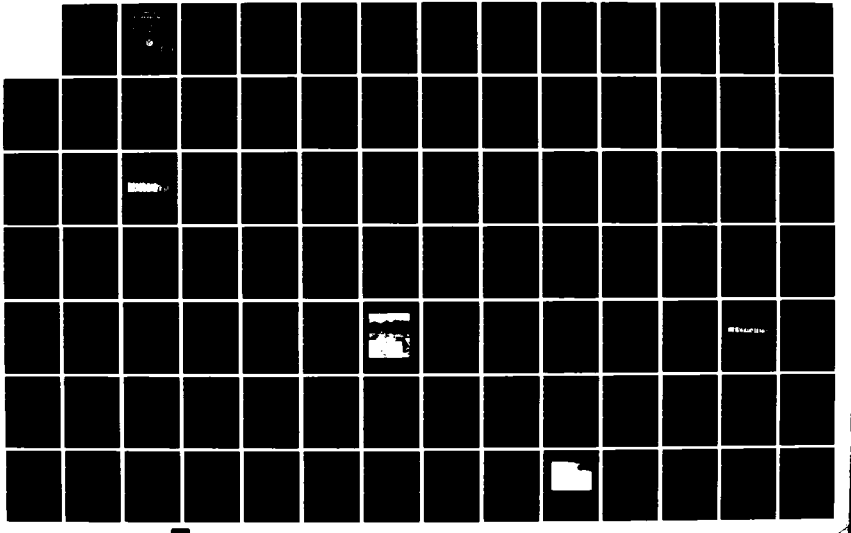
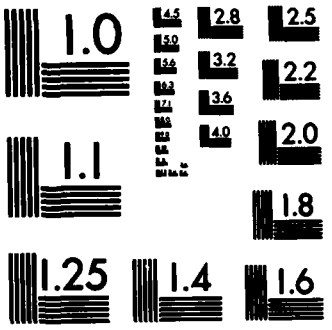
AD-A122 243 SHOTS SUGAR AND UNCLE THE FINAL TESTS OF THE BUSTER-JANGLE SERIES 19 NOVE..(U) JRB ASSOCIATES INC MCLEAN VA J PONTON ET AL. 23 JUN 82 DNA-6025F 1/2

UNCLASSIFIED DNA001-79-C-0473 F/G 15/6 NL

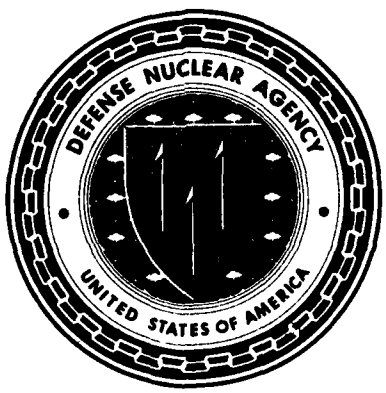




DNA 6025F

SHOTS SUGAR AND UNCLE

The Final Tests of the BUSTER-JANGLE Series 19 November—29 November 1951



United States Atmospheric Nuclear Weapons Tests
Nuclear Test Personnel Review

Prepared by the Defense Nuclear Agency as Executive Agency
for the Department of Defense

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: DNA 6025F	2. GOVT ACCESSION NO.: AD-A122243
3. RECIPIENT'S CATALOG NUMBER:	
4. TITLE *(and Subtitle)*: SHOTS SUGAR AND UNCLE The Final Tests of the BUSTER-JANGLE Series 19 November - 29 November 1951	5. TYPE OF REPORT & PERIOD COVERED: Technical Report
	6. PERFORMING ORG. REPORT NUMBER: ~~JRB 2-816-03-423-00~~
7. AUTHOR(s): Jean Ponton, Jean Massie, Stephen Rohrer, Carl Maag	8. CONTRACT OR GRANT NUMBER(s): DNA 001-79-C-0473
9. PERFORMING ORGANIZATION NAME AND ADDRESS: JRB Associates 8400 Westpark Drive McLean, Virginia 22102	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Subtask U99QAXMK506-08
11. CONTROLLING OFFICE NAME AND ADDRESS: Director Defense Nuclear Agency Washington, D.C. 20305	12. REPORT DATE: 23 June 1982 13. NUMBER OF PAGES: 132
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*:	15. SECURITY CLASS. *(of this report)*: UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A Since UNCLASSIFIED

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

This work was sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B350079464 U99QAXMK50608 H2590D. For sale by the National Technical Information Service, Springfield, Virginia 22161.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Operation BUSTER-JANGLE
SUGAR
UNCLE
Nuclear Tests
Special Weapons Command
Weapons Effects Test Unit
Weapons Development Test Unit
Nevada Proving Ground
Exercises Desert Rock II and III
Radiation Exposure

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes the activities of DOD military and civilian personnel in the final two events of Operation BUSTER-JANGLE, Shots SUGAR and UNCLE, conducted on 19 November and 29 November 1951. DOD personnel participated in the scientific projects conducted by the test units and in Exercises Desert Rock II and III. Radiological safety criteria and procedures were established and implemented during Operation BUSTER-JANGLE to minimize participants' exposure to radiation.

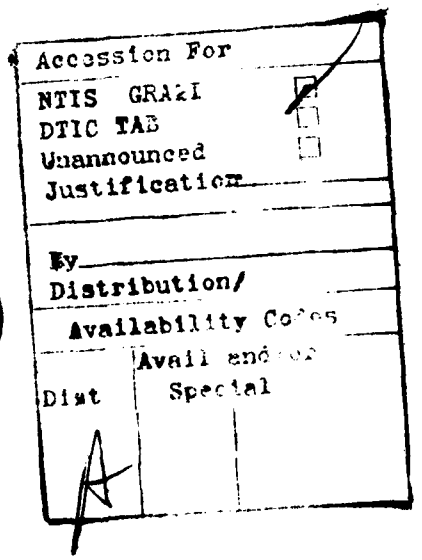
DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

18. SUPPLEMENTARY NOTES (continued)

The Defense Nuclear Agency Action Officer, Lt. Col. H. L. Reese, USAF, under whom this work was done, wishes to acknowledge the research and editing contribution of numerous reviewers in the military services and other organizations in addition to those writers listed in block 7.



PREFACE

Between 1945 and 1962, the U.S. Government, through the Manhattan Engineer District and its successor, the Atomic Energy Commission (AEC), conducted 235 atmospheric nuclear weapons tests at sites in the United States and in the Atlantic and Pacific Oceans. In all, an estimated 220,000 Department of Defense (DOD) participants, both military and civilian, were present at the tests. Of these, approximately 90,000 participated in the atmospheric nuclear weapons tests conducted at the Nevada Proving Ground (NPG),* northwest of Las Vegas, Nevada.

In 1977, 15 years after the last above-ground nuclear weapons test, the Center for Disease Control** noted a possible leukemia cluster among a small group of soldiers present at Shot SMOKY, a weapons-related test of Operation PLUMBBOB, the Nevada test series conducted in 1957. Since that initial report by the Center for Disease Control, the Veterans Administration has received a number of claims for medical benefits from former military personnel who believe their health may have been affected by their participation in the weapons testing program.

In late 1977, DOD began a study to provide data to both the Center for Disease Control and the Veterans Administration on potential exposures to ionizing radiation among the military and civilian participants in atmospheric nuclear weapons testing. DOD organized an effort to:

- Identify DOD personnel who had taken part in the atmospheric nuclear weapons tests

---

*Renamed the Nevada Test Site in 1955. Some of the documents written during Operation BUSTER-JANGLE, however, refer to the area as the NTS.

**The Center for Disease Control is part of the U.S. Department of Health and Human Services (formerly the U.S. Department of Health, Education, and Welfare).

- Determine the extent of the participants' exposure to ionizing radiation
- Provide public disclosure of information concerning participation by DOD personnel in the atmospheric nuclear weapons tests.

METHODS AND SOURCES USED TO PREPARE THIS VOLUME

This report on Operation BUSTER-JANGLE is based on the military and technical documents associated with these atmospheric nuclear weapons tests. Many of the documents pertaining specifically to DOD participation at Shots SUGAR and UNCLE were found in the National Archives, the Defense Nuclear Agency Technical Library, and the Office of Air Force History.

In most cases, the surviving historical documentation of activities conducted at Shots SUGAR and UNCLE addresses test specifications and technical information, rather than personnel data. Moreover, the available documents sometimes have inconsistencies in vital facts, such as the number of DOD participants in a certain project at a given shot or their locations and assignments at a given time. When the documents indicated two different personnel numbers, the higher figure was used.

For several of the Desert Rock exercises and test organization projects discussed in this volume, the only source documents available are the Sixth Army Desert Rock operation orders and the Test Director's schedule of events from "Operation Order 1-51." These sources detail the plans developed by DOD and AEC personnel prior to Operation BUSTER-JANGLE. It is not known if all the projects addressed in the planning documents were conducted exactly as planned. Although some of the after-action documents summarize the projects performed during the series, they do not always supply shot-specific information. In the absence of shot-specific after-action reports, projects are described according to the way they were planned. The references

indicate whether the description of activities is based on the schedule of events, operation orders, or after-action reports.

This volume uses the project titles and agency designations that appear in "Summary Report: Weapons Effects Tests, Operation JANGLE." Information on dates and yields of the detonations, fallout patterns, meteorological conditions, and cloud dimensions is taken from General Electric Company-TEMPO's Compilation of Local Fallout Data from Test Detonations 1945-1962, Extracted from DASA 1251, Volume 1, except in instances where more specific information is available elsewhere.

ORGANIZATION AND CONTENT OF BUSTER-JANGLE SERIES REPORTS

This volume details participation by DOD personnel in the final two events of Operation BUSTER-JANGLE. Two other publications address DOD activities during the series:

- Series volume: Operation BUSTER-JANGLE, 1951
- Multi-shot volume: Shots ABLE to EASY, the First Five Tests of the BUSTER-JANGLE Series.

The volumes addressing the test events of Operation BUSTER-JANGLE are designed for use with one another. The series volume provides general information, such as a discussion of the historical background, organizational relationships, and radiological safety procedures. In addition, it addresses the overall objectives of the operation, describes the layout of the NPG, and contains a bibliography of all works consulted in the preparation of the three BUSTER-JANGLE reports. The multi-shot volumes combine shot-specific descriptions for the seven BUSTER-JANGLE nuclear events. These volumes contain bibliographies only of the sources referenced in each of the two texts. Descriptions of activities concerning any particular shot may be supplemented by the general radiological safety and organizational information contained in the series volume.

Chapter 1 of this volume describes the physical setting and general characteristics of SUGAR and UNCLE and briefly introduces the Desert Rock exercises and the scientific activities in which DOD personnel participated. Chapter 2 addresses SUGAR, and chapter 3 addresses UNCLE. Each of these chapters describes the specific setting and characteristics of the one detonation, DOD personnel activities in the training and scientific projects, and the radiological protection procedures.

The information in this report is supplemented by the Reference Manual: Background Materials for the CONUS Volumes. The manual summarizes information on radiation physics, radiation health concepts, exposure criteria, and measurement techniques. It also contains a list of acronyms and a glossary of terms used in the DOD reports addressing test events in the continental United States.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used in this volume:

AEC	Atomic Energy Commission
AFB	Air Force Base
AFSWP	Armed Forces Special Weapons Project
BJY	BUSTER-JANGLE Y
DOD	Department of Defense
IBDA	Indirect Bomb Damage Assessment
LASL	Los Alamos Scientific Laboratory
NPG	Nevada Proving Ground
R/h	Roentgens per hour
SWC	Special Weapons Command
UTM	Universal Transverse Mercator

CHAPTER 1

INTRODUCTION

Shots SUGAR and UNCLE were tests of nuclear devices conducted on 19 and 29 November 1951 at the Nevada Proving Ground, the continental nuclear test site located northwest of Las Vegas. The shots were the final two detonations of Operation BUSTER-JANGLE, the atmospheric nuclear weapons test series performed from 22 October to 29 November 1951.

The two nuclear devices were developed and built for the Atomic Energy Commission by the Los Alamos Scientific Laboratory (LASL), an AEC nuclear weapons development laboratory. As weapons effects tests, they were part of the JANGLE phase of Operation BUSTER-JANGLE. Shots SUGAR and UNCLE provided the first experimental data on the military effects of surface and underground nuclear detonations. Projects were conducted during JANGLE to determine the (4):*

- Response of structures to nuclear bursts
- Gamma radiation versus time and distance
- Residual contamination from surface and underground bursts.

Two test units, the Weapons Effects Test Unit and the Weapons Development Test Unit, conducted the scientific experiments at SUGAR and UNCLE. The Weapons Effects Test Unit, supervised by the Air Force Special Weapons Command (SWC), fielded projects to evaluate the utility of the two nuclear devices for military application. The Weapons Development Test Unit, consisting of scientists from the Los Alamos Scientific

*All sources cited in the text are listed alphabetically and numbered in the Reference List at the end of this volume.

Laboratory, from Edgerton, Germeshausen, and Grier, Inc., and from the Sandia Corporation, performed diagnostic tests of the nuclear devices by measuring characteristics of the detonation.

The Air Force Special Weapons Command, located at Kirtland Air Force Base (AFB) in Albuquerque, New Mexico, provided cloud-sampling missions, courier flights, cloud-tracking missions, and aerial surveys for SUGAR and UNCLE. It also played a major administrative role in the weapons effects testing.

Table 1-1 summarizes the JANGLE shots, including such information as the UTM* coordinates of the points of detonation and the heights of burst. Figure 1-1 displays a 1951 map of the Nevada Proving Ground, with the positions of the BUSTER-JANGLE tests.

1.1 DEPARTMENT OF DEFENSE PARTICIPATION IN THE FINAL TWO BUSTER-JANGLE EVENTS

A test organization was established to plan, coordinate, and conduct atmospheric nuclear weapons tests during Operation BUSTER-JANGLE. Consisting of personnel from the Atomic Energy Commission and the Department of Defense, the test organization also included representatives of the Special Weapons Command and various contractors. The numerous scientific and diagnostic projects conducted at the final two BUSTER-JANGLE events were fielded by the two test units. Other activities were conducted as part of the military training programs associated with Exercises Desert Rock II and III. These activities, planned and

*Universal Transverse Mercator (UTM) coordinates are used in this report. The first three digits refer to a point on an east-west axis, and the second three refer to a point on a north-south axis. The point so designated is the southwest corner of an area 100 meters square.

Table 1-1: SUMMARY OF THE FINAL TWO OPERATION BUSTER-JANGLE EVENTS (1951)

Shot	SUGAR	UNCLE
Sponsor	DOD	DOD/LASL
Planned Date	15 November	29 November
Actual Date	19 November	29 November
Local Time	0900	1200
NPG Location	Area 9	Area 10
UTM Coordinates	854097	850139
Type of Detonation	Surface	Underground
Height of Burst (feet)	3.5	−17
Yield (kilotons)	1.2	1.2

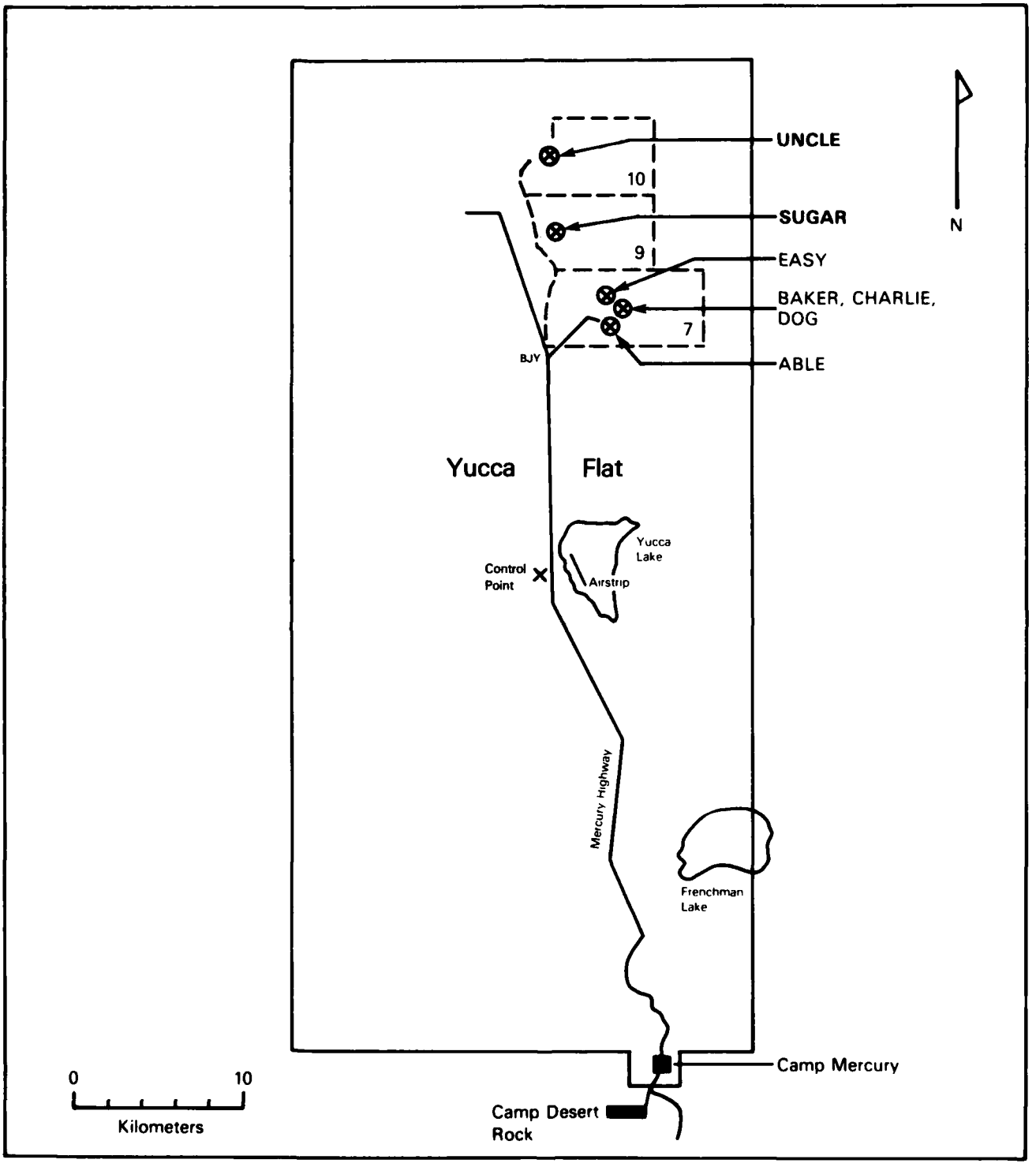


Figure 1-1: LOCATION OF SHOTS SUGAR AND UNCLE AT THE NEVADA PROVING GROUND IN RELATION TO OTHER SHOTS IN THE BUSTER-JANGLE SERIES

conducted by the armed services, were reviewed and approved by the Test Manager to ensure coordination with the test organization.

Department of Defense personnel present at the Nevada Proving Ground during Operation BUSTER-JANGLE participated in three general types of activities: military training programs, support and staff duties, and test assistance and involvement.

Training activities involving DOD personnel were conducted under the Exercise Desert Rock II and III programs. These activities included an orientation and indoctrination program, highlighted by the observation of the nuclear burst. The activities also included weapons effects tests.

Some DOD personnel provided support to the test organization. Others were assigned to the Camp Desert Rock support elements. Soldiers of the III Corps Radiological Safety Unit served as radiological safety monitors for Exercise Desert Rock II and III participants. They were assisted by test organization monitors, including both military and civilian personnel. Soldiers from various Army units maintained and operated Camp Desert Rock, an installation of the U.S. Sixth Army. During Desert Rock I, 2,500 men had performed these duties. However, the support force was reduced for Exercises Desert Rock II and III, since there were fewer Desert Rock participants. These soldiers provided essential support, such as food service and housing, as well as transportation, communications, construction, and security services. Some of these Desert Rock support troops worked in the forward areas of the Nevada Proving Ground to construct observer trenches, lay communication lines, provide transportation, and assist in other preparations for Desert Rock activities. Many of the Camp Desert Rock personnel observed at least one detonation during Operation

BUSTER-JANGLE, and some were called upon to perform support or staff duties in the test areas during the nuclear detonations.

In the area of test assistance and participation, personnel from DOD agencies and all four armed services fielded the military effects projects conducted by the Weapons Effects Test Unit and supported projects performed by the Weapons Development Test Unit. Participants in test unit projects generally placed data-collection instruments around ground zero in the weeks before the scheduled detonation. They returned to recover the equipment after the detonation, when the Test Manager determined that the radiological environment in the shot area would permit limited access. During a nuclear detonation, project personnel were generally positioned at designated observer locations or were operating equipment or aircraft. About 750 DOD personnel from units and groups of the test organization participated in or supported field operations at Shots SUGAR and UNCLE.

An estimated 500 SWC personnel provided air support to the Test Manager and various test unit projects. During Operation BUSTER-JANGLE, SWC consisted of units of the 4925th Test Group (Atomic) and the 4901st Support Wing (Atomic). The 4925th Test Group operated out of Indian Springs AFB, 30 kilometers* east of Camp Mercury, while the 4901st Support Wing operated out of Kirtland AFB.

1.2 TEST ORGANIZATION ACTIVITIES AT THE FINAL TWO BUSTER-JANGLE EVENTS

The Weapons Effects Test Unit and the Weapons Development Test Unit conducted scientific and diagnostic projects at Shots

*Throughout this report, surface distances are given in metric units. The metric conversion factors include: 1 foot = 0.30 meters; 1 yard = 0.91 meters; 1 mile = 1.6 kilometers. Altitudes and other vertical heights are given in feet.

SUGAR and UNCLE. Department of Defense participants in these projects followed radiological protection procedures established by tne AEC. These procedures, which are described in the Operation BUSTER-JANGLE volume, were designed to minimize exposure to ionizing radiation. Except for SWC sampling pilots, participants were to receive no more than 8 roentgens during the entire operation. Sampling pilots were authorized to receive up to 3.9 roentgens during the operation. To implement these criteria, the test organization Radiological Health and Safety Group controlled access to radiation areas, and project personnel recovering test instruments from these areas were accompanied by radiological safety monitors. The monitors, who measured radiation intensities in the recovery area, recommended that recovery operations cease if intensities were too great or the length of time spent by participants in the areas was too long. To monitor cumulative exposures, most project personnel were issued film badges and pocket dosimeters. These film badges and dosimeters were collected, developed, and evaluated at regular intervals, and any individual whose cumulative exposure approached or exceeded the established limits was barred from further participation in project activities conducted in the forward area. Personnel decontamination procedures were implemented, and emergency evacuation plans were prepared for both test events.

Complete decontamination, including showers and changes into clean clothing, was required of cloud-sampling personnel following each project mission, regardless of the exposure received on the flight. Other aircrew members underwent decontamination procedures as necessary. Aircraft were either decontaminated by washing or were isolated until radiation intensities decayed to predetermined levels (33).

1.3 EXERCISE DESERT ROCK II AND III ACTIVITIES AT THE FINAL TWO BUSTER-JANGLE EVENTS

Many of the DOD personnel involved in Shots SUGAR and UNCLE were participants in Exercises Desert Rock II and III, respectively. The Desert Rock exercises were part of the Armed Forces' newly instituted program to train personnel in the use and effects of nuclear weapons and to test battlefield doctrine and tactics.

DOD personnel participated at the shots in two Desert Rock programs:

- The observer activities, which involved witnessing a nuclear detonation
- Evaluation of the effects of the nuclear device on military equipment and field fortifications.

The Camp Desert Rock troops provided support, including radiological safety monitoring, for these activities (37; 61).

Radiation protection procedures of Exercises Desert Rock II and III, like those of the test organization, are detailed in the Operation BUSTER-JANGLE volume. Camp Desert Rock personnel and exercise participants were limited to no more than 3 roentgens of exposure during Exercises Desert Rock II and III. The radiation protection procedures of Exercise Desert Rock included provisions for (37; 61):

- Maintaining minimum safe distances from the nuclear detonations
- Controlling access to radiation areas
- Film-badging Desert Rock personnel
- Monitoring individuals working in radiation areas
- Monitoring the cumulative doses of Desert Rock personnel

- Decontaminating personnel and equipment
- Establishing emergency evacuation plans.

These procedures were intended to minimize exposure while still allowing Desert Rock personnel to accomplish their missions.

SHOT SUGAR SYNOPSIS

AEC TEST SERIES:	BUSTER-JANGLE
DOD EXERCISE:	Desert Rock II
DATE/TIME:	19 November 1951, 0900 hours
YIELD:	1.2 kilotons
HEIGHT OF BURST:	3.5 feet (near ground surface)

Purpose of Test: (1) Determine the militarily useful effects of surface nuclear detonations
(2) Evaluate equipment and techniques developed for military operations using nuclear weapons.

DOD Objective: To evaluate the utility of the nuclear device for military application; to instruct DOD personnel in the effects of a nuclear detonation.

Weather: At shot-time, the temperature was 1°C, the relative humidity was 47 percent, and the pressure was 872 millibars. The winds were two knots from the south at surface level, 32 knots from the south-southwest at 10,000 feet, and 40 knots from the south-southwest at 14,000 feet.

Radiation Data: Onsite fallout was relatively heavy north of ground zero. Twenty-two hours after the shot, radiation intensities ranging from 1 R/h* to 0.01 R/h stretched 6.3 kilometers north of ground zero, covering an area of about 25 square kilometers.

Participants: Los Alamos Scientific Laboratory; Exercise Desert Rock II troops; Naval Ordnance Laboratory; Air Force Cambridge Research Center; Air Weather Service; Headquarters, Air Force; Signal Corps Engineering Laboratories; Air Research and Development Command; Naval Radiological Defense Laboratory; Engineer Research and Development Laboratories; Naval Medical Research Institute; Army Chemical Center; Special Weapons Command; Wright Air Development Center; Ballistics Research Laboratories; contractors.

---

*Roentgen per hour

CHAPTER 2

SHOT SUGAR

Shot SUGAR, the sixth nuclear test of Operation BUSTER-JANGLE, was detonated with a yield of 1.2 kilotons at 0900 hours Pacific Standard Time on 19 November 1951. The SUGAR device was detonated 3.5 feet above the ground in Area 9 of Yucca Flat, UTM coordinates 854097. The Los Alamos Scientific Laboratory developed the SUGAR device, and the Department of Defense sponsored the shot. The bottom of the Shot SUGAR cloud reached an altitude of 11,000 feet, while the top rose to 15,000 feet.* The cloud drifted north-northeast from the point of detonation. Onsite fallout was relatively heavy north of ground zero. Offsite fallout occurred to the north (27).

Shot SUGAR was a weapons effects test, the first of the JANGLE phase of Operation BUSTER-JANGLE. The main purpose of the JANGLE tests was to determine the militarily useful effects of surface and underground nuclear detonations. Another objective was to evaluate equipment and techniques developed for military operations using nuclear weapons (4).

2.1 EXERCISE DESERT ROCK II OPERATIONS

Exercise Desert Rock II operations involved an unknown number of observers and an estimated 50 evaluation team personnel at Shot SUGAR. About 50 additional Camp Desert Rock troops, whose activities are discussed in the first part of this section,

*Throughout this report, altitudes are measured from mean sea level, unless otherwise noted. Yucca Flat, where the BUSTER-JANGLE tests were conducted, is approximately 4,000 feet above mean sea level.

provided radiological safety, instruction, transportation, communications, and medical functions for Desert Rock activities in the forward area (37).

2.1.1 Camp Desert Rock Personnel

Table 2-1 identifies the service units of Camp Desert Rock troops (37). A minus (-) in a designation indicates that the unit was not fully represented. A plus (+) indicates that the unit was augmented with personnel from other units.

Camp Desert Rock personnel participating in Desert Rock activities gave administrative, logistical, and operational assistance to the observers and evaluation teams. In performing these duties, approximately 50 personnel sometimes entered the forward area. Three units particularly involved in shot-day operations were the Control Group, the Radiological Safety Unit, and the Advisory Group.

The Control Group, composed of members of the Camp Desert Rock staff sections, along with military police and signal personnel, accompanied the troops into the forward area. This group's duties were to supervise Desert Rock operations and to maintain contact with the Exercise Director.

The Radiological Safety Unit, directed by the Desert Rock Chemical Officer, implemented radiological safety criteria under the supervision of test organization personnel. Its duties included (37):

- Issuing and collecting film badges
- Providing radiological safety monitors to supplement test organization monitors
- Conducting radiological surveys after the initial test organization survey
- Accompanying observers and evaluation teams on their postshot inspections of the equipment displays

Table 2-1: SUPPORT UNITS ATTACHED TO CAMP DESERT ROCK, EXERCISE DESERT ROCK II

UNIT	HOME STATION
Headquarters	
Headquarters and Headquarters Battery, III Corps Artillery	Fort Lewis, Washington
Engineer	
231st Engineer Combat Battalion	Fort Lewis
359th Engineer Utility Detachment	Camp Cooke, California
90th Engineer Water Supply Company	Fort Lewis
Detachment, 597th Light Equipment Company	Fort Huachuca, Arizona
Detachment, 705th Engineer Field Maintenance Company	Fort Huachuca
Transportation	
4th Transportation Truck Company	Camp Stoneman, California
Detachment, 92nd Transportation Car Company	Camp Roberts, California
Detachment, 562nd Transportation Staging Area Company	Camp Stoneman
Military Police	
Company "A," 505th Military Police Battalion	Camp Roberts
Company "C," 505th Military Police Battalion	Camp Roberts

Table 2-1: SUPPORT UNITS ATTACHED TO CAMP DESERT ROCK, EXERCISE DESERT ROCK II (Continued)

UNIT	HOME STATION
Signal	
Detachment, Headquarters and Headquarters Company, 303rd Signal Service Battalion (+)	Camp Cooke
Detachment, Headquarters and Headquarters Company, Company "B," 314th Signal Service Battalion (-)	Camp Cooke
Detachment, 504th Signal Base Maintenance Company	Sacramento Signal Depot, California
Medical	
94th Veterinary Food Inspection Detachment	Fort Lewis
Ordnance	
Headquarters and Headquarters Detachment, 393rd Ordnance Battalion	Camp Cooke
161st Ordnance Depot Company (-)	Camp Cooke
3623rd Ordnance Company	Camp Cooke
Quartermaster	
Detachment, 523rd Quartermaster Subsistence Depot Company (-)	Utah General Depot
Detachment, Headquarters and Headquarters Company, 53rd Quartermaster Base Depot Company	Utah General Depot
Detachment, 539th Quartermaster Laundry Company	Fort Lewis

Table 2-1: SUPPORT UNITS ATTACHED TO CAMP DESERT ROCK, EXERCISE DESERT ROCK II (Continued)

UNIT	HOME STATION
621st Quartermaster Service Company	Fort Lewis
Adjutant General	
806th Army Postal Unit	Fort Lewis

- Establishing decontamination stations and procedures.

The Advisory Group, consisting of three officers from the Armed Forces Special Weapons Project (AFSWP), was assigned to Camp Desert Rock on a temporary basis to provide technical assistance and advice to Desert Rock personnel. Before the shot, the Advisory Group instructed observers in nuclear weapons and their effects. After the detonation, the group briefed the participants as they toured the equipment displays. In addition, the group assisted the evaluation teams in assessing and then preparing reports on the effects of the detonation on the displays.

Besides the Control Group, the Radiological Safety Unit, and the Advisory Group, several other Desert Rock support elements engaged in activities before shot-day and on the day of detonation. From 12 through 14 November, members of the 231st Engineer Combat Battalion constructed field fortifications in the display areas. On shot-day, transportation personnel conveyed observers to a location nine kilometers south of ground zero, where they witnessed the detonation. In the days after the detonation, transportation personnel conveyed the observers and evaluation teams into the forward area to inspect the displays.

Military police provided traffic control in Camp Desert Rock and in the forward area during the rehearsals conducted before shot-day and during the activities on the day of detonation and on the following days. Signal Corps personnel established wire and radio communications within the forward area, as well as at Camp Desert Rock (37).

2.1.2 Observer Activities

All observers were from the Army. They took part in orientation and training activities before the event. In the days immediately preceding the detonation, instructors from the Advisory Group used films and lectures to brief the observers on the characteristics of a nuclear detonation and the procedures to follow during a nuclear test.

At approximately 0630 hours on 19 November, the observers left Camp Desert Rock in a bus convoy for the observer location, nine kilometers south of ground zero. They arrived at the observation point, indicated in figure 2-1, at about 0815 hours. Advisory Group instructors then conducted a brief preshot orientation. Shortly before the shot, the instructors directed the observers to sit on the ground with their backs toward ground zero (37).

After the initial flash of light from the detonation, which occurred at 0900 hours, the instructors directed observers to turn and view the fireball and cloud. Figure 2-2 shows the troops at the observation point watching Shot SUGAR. At about 0915, the observers began the return trip to Camp Desert Rock (37).

At least one day after the shot, the observers returned to tour the display areas in a bus convoy. Signal Corps personnel

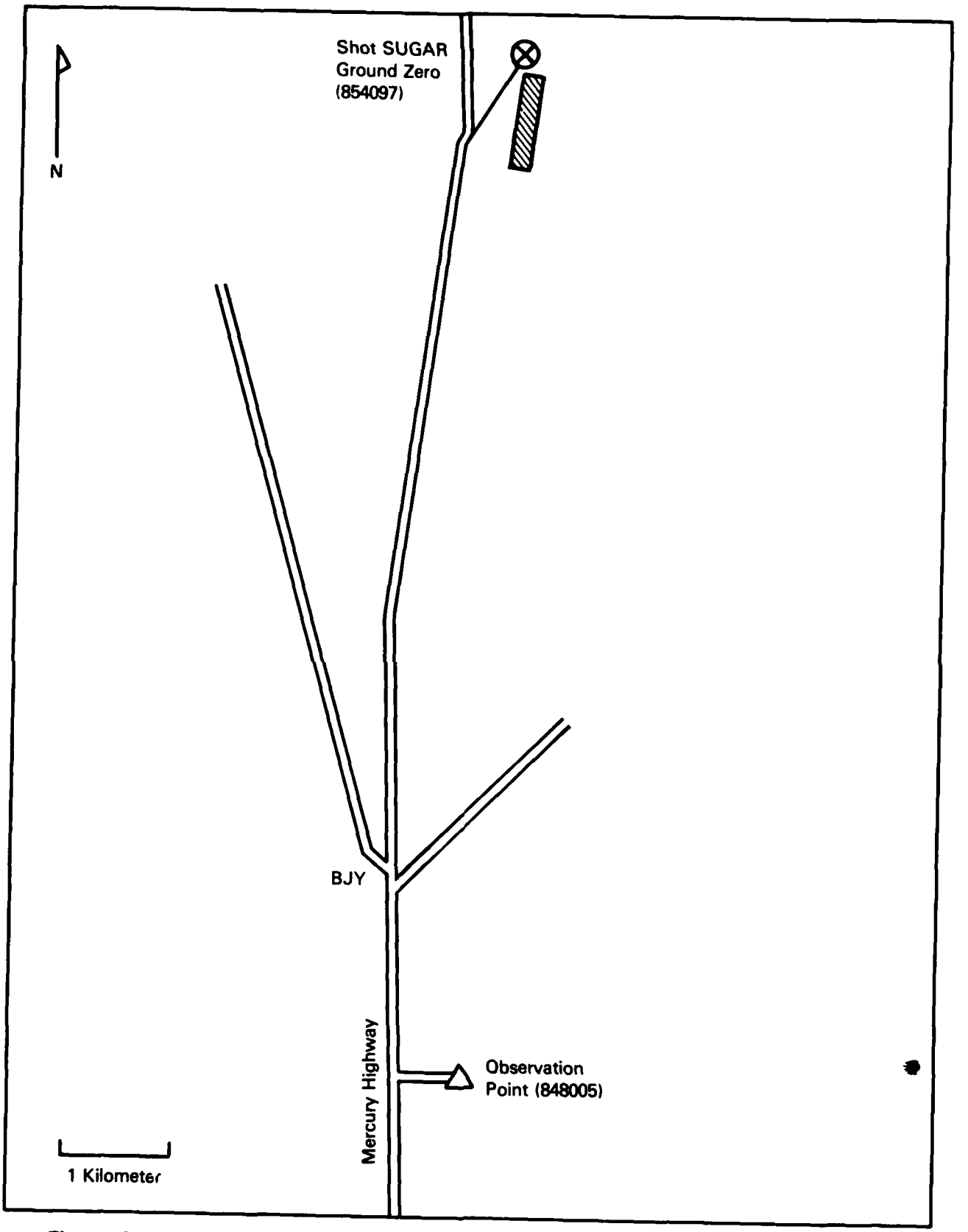


Figure 2-1: LOCATION OF DISPLAY AREAS, FOXHOLES, AND OBSERVATION POINT FOR EXERCISE DESERT ROCK II

Figure 2-2: TROOPS AT THE OBSERVATION POINT WATCHING SHOT SUGAR

issued a film badge to each observer entering a bus. A radiological safety monitor from the Chemical Section accompanied each busload of observers (37).

The six display areas were 90 to 910 meters south of ground zero, as shown in figure 2-1. Two rows of two-man foxholes were interspersed among the display areas. In addition, 27 test animals had been placed along arcs 760, 1,530, and 2,440 meters northeast of ground zero. These animals were also used in Project 2.7 (37; 64).

Personnel remained on the buses as they traveled through the display areas. During the tour, Advisory Group instructors briefed the observers concerning the effects of the detonation on military equipment and field fortifications (37).

2.1.3 Damage Effects Tests

Five evaluation teams studied the effects of the SUGAR detonation on military equipment and foxholes. Teams came from each of the following Camp Desert Rock sections: Chemical, Signal, Engineer, Ordnance, and Quartermaster. Each team was responsible for constructing equipment displays in the display area shown in figure 2-1, for recovering test equipment after the detonation, and for preparing a report of its findings (37).

For about a week before the detonation, the teams constructed their displays, with the assistance of the 231st Engineer Combat Battalion. In addition, they instrumented foxholes with film badges to indicate the radiation exposure personnel could have received had they been in these fortifications during the detonation (37).

The Officer in Charge, Effects Tests, posted a guard at each display position at 1600 hours two days before the shot. The

guards were to keep unauthorized personnel out of the shot area and to see that no equipment or material was moved without the authority of the Officer in Charge. Personnel from Desert Rock S-3, Operations, relieved the guards during the night before the detonation or on shot-day. After the day of detonation, the guards returned to the display positions, where they remained until relieved by the Officer in Charge (37).

Within five days after the shot, the teams had evaluated the damage to the equipment and fortifications in the display area. A radiological monitor accompanied each team to prevent personnel from entering any area with radiation intensities considered hazardous. The 231st Engineer Combat Battalion, which had constructed the foxholes, recovered materials placed in the foxholes, removed equipment, and backfilled any holes in the display areas (37).

In preparing their reports, the teams received technical information from the Advisory Group. The LASL Graphic Arts Group provided photographs of the weapons effects tests for the reports (37).

2.2 DEPARTMENT OF DEFENSE PARTICIPATION IN SCIENTIFIC AND SUPPORT ACTIVITIES AT SHOT SUGAR

Department of Defense personnel took part in scientific projects conducted at Shot SUGAR by the Weapons Effects Test Unit and the Weapons Development Test Unit. Table 2-2 lists these projects by number and title and identifies the fielding organizations. In addition to direct participation in test unit projects, the DOD provided support to the test units and the Test Manager. These activities involved about 550 DOD project personnel, 450 SWC air and ground personnel, and perhaps an additional 100 DOD personnel working for various units coordinated by the test organization.

Table 2-2: TEST UNIT PROJECTS, SHOT SUGAR

Project	Title	Participants
	Weapons Effects Tests	
1.1	Ground Acceleration Measurement	Naval Ordnance Laboratory
1.2a-1	Peak Air Blast Pressures from Shock Velocity Measurements	Ballistics Research Laboratories
1.2a-2	Transient Ground Mechanical Effects from HE and Nuclear Explosions	Ballistics Research Laboratories
1.3a	Free Air Shock Arrival Times	Brookhaven National Laboratory
1.3b	Peak Pressure versus Distance in Free Air Using Smoke and Rocket Photography	Naval Ordnance Laboratory
1.3c	The Measurement of Free Air Atomic Blast Pressures	Air Force Cambridge Research Center; 6531st Flight Test Squadron
1.4	Free Air Pressure Measurements	Sandia Corporation
1.5a	Transient Ground Displacement Measurement	Naval Ordnance Laboratory
1.6	Earth Displacement (Shear Shafts)	Ohio River Division Laboratories; Office, Chief of Engineers
1.7	Ground Acceleration (Shock Pins)	Massachusetts Institute of Technology; Office, Chief of Engineers
1(8)b	Air Weather Service Participation in Operation JANGLE	2060th Mobile Weather Squadron
2.1a	Gamma Radiation as a Function of Time and Distance	Evans Signal Laboratory; National Bureau of Standards
2.1b	Gamma Radiation as a Function of Time with Droppable Telemeters	Naval Air Development Center
2.1c-1	Aerial Survey of Distant Contaminated Terrain	Headquarters, Air Force
2.1c-2	Aerial Survey of Local Contaminated Terrain	Bureau of Aeronautics; Air Research and Development Command; Wright Air Development Center
2.1d	Monitor Survey of Ground Contamination	Naval Radiological Defense Laboratory; Radiological Health and Safety Group of LASL, AFSWP
2.3-1	Total Gamma Radiation Dosage	Evans Signal Laboratory
2.3-2	Foxhole Shielding of Gamma Radiation	Engineer Research and Development Laboratories
2.4a	Beta-ray and Gamma-ray Energy of Residual Contamination	Naval Radiological Defense Laboratory
2.4b	Gamma Depth Dose Measurement in Unit-density Material	Naval Medical Research Institute
2.4c	Gamma Ray Spectrum Measurements of Residual Radiation	Brookhaven National Laboratory
2.5a-1	Airborne Particle Studies	Army Chemical Center
2.5a-2	Fallout Particle Studies	Naval Radiological Defense Laboratory
2.5a-3	Radiochemical Studies of Large Particles	Army Medical Service Graduate School

Table 2-2: TEST UNIT PROJECTS, SHOT SUGAR (CONTINUED)

Project	Title	Participants
	Weapons Effects Tests (Continued)	
2.6a	Remotely Controlled Sampling Techniques	Evans Signal Laboratory; Coles Signal Laboratory
2.6c-1	Nature and Distribution of Residual Contamination I	National Institutes of Health; Public Health Service
2.6c-2	Nature and Distribution of Residual Contamination II	Naval Radiological Defense Laboratory; Evans Signal Laboratory
2.6c-3	Retrievable Missiles for Remote Ground Sampling	National Institutes of Health; Public Health Service
2.7	Biological Injury from Particle Inhalation	National Institutes of Health
2.8	Analysis of Test Site and Fallout Material	Department of Agriculture
4.1	Aerial Technical Photography	Wright Air Development Center
4.1a.1	Ground Technical Photography Material Operation	Wright Air Development Center
4.1a.2	Photographic Analysis	Wright Air Development Center
4.2	Cratering Effects of Underground surface Detonated Atomic Bombs and Influence of Soil Characteristics on Crater	Naval Civil Engineering Research and Evaluation Laboratory
6.1	Evaluation of Military Radiac Equipment	Evans Signal Laboratory; Bureau of Ships
6.2	Protection and Decontamination of Land Targets and Vehicles	Naval Radiological Defense Laboratory; Engineer Research and Development Laboratories; Army Chemical Center; Office, Chief of Engineers
6.3.1	Evaluation of Military Individual and Collective Protection Device and Clothing	Army Chemical Center
6.3.2	Evaluation of Potential Respiratory Hazards Associated with Vehicular Operations in a Radioactively Contaminated Area	Ballistics Research Laboratories; Army Field Forces Board Number 2 Test Team; Army Chemical Center
6.7	Clothing Decontamination and Evaluation of Laundry Methods	9135th Test Support Unit; Office of the Quartermaster General; Evans Signal Laboratory
6.8	Evaluation of U.S. Army Field Water Supply Equipment and Operations	Engineer Research and Development Laboratories
7.1a	Transport of Radiation Debris	Headquarters, Air Force; Air Weather Service
7.1b	Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris	Headquarters, Air Force; 4925th Test Group
7.2	Seismic Waves from A Bombs Detonated over a Land Mass	1009th Special Weapons Squadron; Naval Ordnance Laboratory; Wright Air Development Center; Coast and Geodetic Survey
7.3	Airborne Low frequency Sound from the Atomic Explosions during Operations BUSTER and JANGLE	Naval Electronics Laboratory; Signal Corps Engineering Laboratories; National Bureau of Standards
	Weapons Development Tests	
10.4	Radiochemical Results	Los Alamos Scientific Laboratory

2.2.1 Weapons Effects Tests

The Weapons Effects Test Unit conducted a number of projects at Shot SUGAR, as indicated in table 2-2. Project participants spent several weeks before the detonation placing and calibrating various types of instruments and gauges.

Project 1.1, Ground Acceleration Measurement, was conducted by the Naval Ordnance Laboratory. The principal objective was to study the characteristics of ground acceleration resulting from a surface detonation. Project participants placed accelerometers and pressure guages at an estimated 16 stations located 90 to 930 meters south-southwest of the SUGAR ground zero. Four hours before the detonation, personnel left the shot area after charging batteries in a recording station 2,480 meters south-southwest of ground zero. They recovered records from the station after the detonation (50; 55).

Project 1.2a-1, Peak Air Blast Pressures from Shock Velocity Measurements, was conducted by the Ballistics Research Laboratories. The objective was to study airblast effects in relation to ground shock effects. Four participants and a monitor were to begin recovering gauges from 12 stations 90 to 910 meters south of ground zero at 0730 hours on the day after the detonation (19; 55).

Project 1.2a-2, Transient Ground Mechanical Effects from HE [High Explosives] and Nuclear Explosions, was conducted by the Ballistics Research Laboratories. The objective was to measure ground shock phenomena. The same four participants and monitor who performed Project 1.2a-1 were to begin recovering gauges from 12 stations 90 to 910 meters south of ground zero at 0730 hours on the day after the detonation (3; 55).

Project 1.3a, Free Air Shock Arrival Times, was conducted by Brookhaven National Laboratory. The objective was to measure the

time of arrival of the blast wave in free air resulting from a surface detonation. Project personnel took measurements with pressure gauges suspended from balloons (59).

Sixteen hours before the detonation, participants placed a timing unit, used to start a pressure recording system, near the SUGAR device. Six hours before the detonation, four project participants and seven workers began suspending gauges from balloons at a station 910 meters south of ground zero. One participant arrived an hour later at a telemetry station 13 kilometers south of ground zero. Two hours and 15 minutes before the detonation, the four project participants at the station 910 meters south of ground zero proceeded toward the telemetry station and the seven workers left the shot area. Participants left the telemetry station two hours after the detonation to analyze the data obtained from the stations (55; 59).

Project 1.3b, Peak Pressure versus Distance in Free Air Using Smoke and Rocket Photography, was conducted by the Naval Ordnance Laboratory. The objective was to determine the peak overpressure along the ground and in the air above a surface detonation. Project personnel used high-speed photographs of smoke rocket trail distortions to measure blast pressures. Fourteen hours before the detonation, participants placed smoke rocket launchers at various locations in the shot area. They positioned the cameras 4,570 meters from ground zero (52; 55).

Project 1.3c, The Measurement of Free Air Atomic Blast Pressures, was conducted by the Air Force Cambridge Research Center and the 6531st Flight Test Squadron of the Rome Air Development Center. The objective was to measure free-air blast pressures using instrumented canisters deployed from aircraft. Two B-29 aircraft, provided by the 6531st Flight Test Squadron and having a crew of ten each, dropped eight canisters. One B-29 flew at an altitude of 15,800 feet and the other at an altitude

of 35,800 feet. On the ground, radar guided the two B-29s to the proper drop point, a telemetry station received pressure data from the canisters, and a tracking system monitored the location of the canisters (32).

The following activities took place seven hours before the detonation (55):

- Ten project participants arrived at the radar station, about 13 kilometers south of ground zero. They remained there through shot-time.
- Two participants arrived at the Control Point weather office to furnish weather information.
- Eight participants arrived at the Program 1 telemetry station, 13 kilometers south of ground zero.
- Two participants arrived at tracking station 1, eight kilometers southwest of ground zero.
- One participant arrived at tracking station 2, about nine kilometers west of ground zero.
- Four participants arrived at tracking stations 5 and 6, at unspecified distances from ground zero.*

An hour later, two participants arrived at tracking station 3, about eight kilometers southeast of ground zero. Four hours before the detonation, some of the participants arrived at the radar station. An hour later, another participant arrived at tracking station 2, and two additional persons arrived at station 1 after having started the equipment at station 4, about three kilometers south of ground zero. Thirty minutes after the shot, personnel left tracking station 3 and the radar station. Forty-five minutes after the detonation, personnel left the other stations (32; 55).

---

*Stations 5 and 6 are mentioned in the AEC operation order (55) but not in the Project 1.3c weapons test report (32). These stations may not have been functioning during the actual test.

Project 1.4, Free Air Pressure Measurements, was conducted by Sandia Corporation. The objective was to record blast pressures at ground-level stations for a surface detonation. Project participants placed gauges around ground zero before the detonation. Two hours before the shot, two participants arrived at the Program 1 station 13 kilometers south of ground zero. After the declaration of recovery hour, four participants and a monitor retrieved blast records 520 to 1,280 meters from ground zero (39; 55).

Project 1.5a, Transient Ground Displacement Measurement, was conducted by the Naval Ordnance Laboratory. The objective was to measure the transient ground displacement caused by a surface detonation and to correlate this displacement with ground acceleration and damage to structures. Before the shot, project personnel placed markers in the ground at ten stations 90 to 580 meters south of ground zero. In addition, they oriented a camera station, located 1,530 meters east of ground zero, toward the markers. During the detonation, the camera filmed the markers' movement resulting from the shot. Participants retrieved the film and measured marker displacement after the area was opened for recovery operations (51; 55).

Project 1.6, Earth Displacement (Shear Shafts), was conducted by the Ohio River Division Laboratories and the Office, Chief of Engineers. The objective was to determine the limits and amounts of permanent displacement in areas surrounding craters caused by a surface detonation. Project participants installed instruments in a series of deep shafts 230 meters east and west and 300 meters south of ground zero. Several weeks later, they retrieved the data to determine permanent earth displacement (56).

Project 1.7, Ground Acceleration (Shock Pins), was conducted by the Massachusetts Institute of Technology for the Office,

Chief of Engineers. The objective was to determine if shock pins would furnish reliable data regarding magnitude of ground shock associated with a nuclear detonation. Before the detonation, project personnel installed metal shock pins two feet into the ground at stations about 190 to 380 meters east and west of ground zero and 170 to 560 meters south of ground zero. Participants reentered the shot area after the declaration of recovery hour to examine the exterior of each shock pin station. Excavating crews later uncovered the shelters, enabling project personnel to photograph the positions of the shock pins (30; 55).

Project 1(8)b, Air Weather Service Participation in Operation JANGLE, was conducted by the 2060th Mobile Weather Squadron of the Air Weather Service. The activity was a continuation of Project 8.2, Air Weather Service Participation in Operation BUSTER. The objective, like that of Project 8.2, was to gather and report weather information before the detonation, including data on wind conditions, temperature, and humidity. Project personnel worked from a weather station at the Control Point and from outlying stations at Tonopah, Warm Springs, Currant, Pioche, and Alamo, Nevada, and at St. George, Utah (43).

Project 2.1a, Gamma Radiation as a Function of Time and Distance, was conducted by the Evans Signal Laboratory and the National Bureau of Standards. The objective was to measure gamma intensity in order to assess the radiation effects of a surface burst. Nine hours before the detonation, five project personnel finished checking radiation detectors at stations 610 to 4,650 meters from ground zero. The stations were primarily north-northwest to north-northeast of ground zero. Three hours before the detonation, nine participants in two vehicles traveled from the Control Point to a recorder station five kilometers west of ground zero. The trip took 45 minutes. Four hours after the detonation, three participants relieved personnel who had gone to the recorder station shortly after the detonation. Four

personnel relieved the second group of participants at the recorder station at 0730 hours on the day following the detonation (14; 55).

Project 2.1b, Gamma Radiation as a Function of Time with Droppable Telemeters, was conducted by the Naval Air Development Center. The objective was to measure gamma intensity in and around the crater following the burst (11).

Fourteen hours before the detonation, two project participants installed telemetering instruments at eight-meter intervals 310 to 920 meters northeast of ground zero. The instruments transmitted data on shot-day to the Program 1 station 13 kilometers south of ground zero. Project personnel entered the station several hours before the shot and operated equipment during the detonation and for 15 to 25 minutes thereafter.

The measurement of residual radiation involved a Navy P2V-2 aircraft, which left Kirtland AFB for the Nevada Proving Ground one hour before the detonation. The aircraft had flown half the distance to the NPG by the time the nuclear device was detonated. Two hours after the detonation, the aircraft dropped radiac telemetry units into the crater area (11; 55).

Project 2.1c-1, Aerial Survey of Distant Contaminated Terrain, was conducted by Headquarters, Air Force. The objectives were to determine by use of instrumented aircraft the radiation levels of fallout from the Shot SUGAR cloud and to test the efficiency of various airborne instruments in detecting radioactivity (31). The aircraft from this project were under the operational control of SWC and are discussed in section 2.2.3.

Project 2.1c-2, Aerial Survey of Local Contaminated Terrain, was conducted by the Navy Bureau of Aeronautics, Air Force Air

Research and Development Command, and Wright Air Development Center. The objective was to test the ability of airborne radiac equipment to detect gamma emitters on the ground. After the detonation, two instrumented aircraft, a Navy P2V-2 and an Air Force B-17, orbited over ground zero at altitudes of 8,000 feet and 10,000 feet, respectively. Participants aboard the aircraft monitored and recorded radiation levels for an hour after the detonation. The aircraft then surveyed the shot area at heights of 500 to 2,000 feet above the crater and its vicinity. Upon completing their mission, the aircraft returned to Kirtland AFB (55; 67).

Project 2.1d, Monitor Survey of Ground Contamination, was conducted by the Naval Radiological Defense Laboratory, the Radiological Health and Safety Group of LASL, and AFSWP. The objective was to determine the extent and magnitude of the radiation field in the shot area, as measured by survey teams. At various times up to one month after the detonation, the teams monitored radiation intensities in the area. Radiological safety monitors accompanied the project monitors in their activities (42).

Project 2.3-1, Total Gamma Radiation Dosage, was conducted by the Evans Signal Laboratory. The objective was to use various types of dosimeters and film badges to determine gamma radiation exposure. Sixteen hours before the detonation, three teams, each consisting of two persons, placed dosimeters at 108 stations 300 meters to 15 kilometers in various directions from ground zero. They recovered the dosimeters two days after the shot (24; 55).

Project 2.3-2, Foxhole Shielding of Gamma Radiation, was conducted by the Engineer Research and Development Laboratories. The objective was to evaluate the protection afforded by foxholes against gamma radiation emitted from a surface nuclear detonation. Sixteen hours before the detonation, three teams, each

consisting of two personnel, placed dosimeters in foxholes 610 to 1,530 meters northeast of ground zero. They recovered the dosimeters two days later (55; 70).

Project 2.4a, Beta-ray and Gamma-ray Energy of Residual Contamination, was conducted by the Naval Radiological Defense Laboratory. The objective was to determine the energy spectra of residual beta and gamma radiation. Before the shot, project personnel placed dosimeters at 13 stations 300 to 1,830 meters northwest of ground zero, 20 stations 430 to 3,660 meters north of ground zero, 13 stations 300 to 1,830 meters northeast of ground zero, and seven stations 730 to 2,000 meters south of ground zero.

Within five hours after the detonation, project personnel retrieved dosimeters from six stations 1,060 to 1,530 meters northwest of ground zero. By six hours after the shot, project personnel had retrieved dosimeters from 12 stations located 610 to 1,830 meters northeast of ground zero and from the seven stations south of ground zero. Within 27 hours after the shot, project personnel had retrieved all dosimeters located north of ground zero, one located 300 meters northeast of ground zero, and one located 1,830 meters northwest of ground zero. By 28 hours after the detonation, project personnel had recovered the last dosimeters, located at six stations 300 to 980 meters northwest of ground zero (68; 74).

Project 2.4b, Gamma Depth Dose Measurement in Unit-density Material, was conducted by the Naval Medical Research Institute. The objective was to determine dose caused by initial and residual gamma radiation. Twelve hours before the detonation, four project personnel placed instrumented phantoms (mannequins made of masonite approximating the density of human tissue) 690 to 1,070 meters west and slightly south of ground zero. Four

participants recovered the phantoms from these stations one hour after the announcement of recovery hour (12; 55).

Project 2.4c, Gamma Ray Spectrum Measurements of Residual Radiation, was conducted by Brookhaven National Laboratory. The objective was to determine the energy spectrum of residual gamma radiation resulting from a surface nuclear detonation. Two hours after the detonation, five project personnel and a monitor proceeded by truck to an area south of ground zero, where they took spectral measurements. Four hours after the detonation, they made their closest approach to ground zero (460 meters), where the radiation intensity was 0.04 R/h. Participants also took measurements 29, 52, 53, and 55 hours after the detonation. The highest intensity encountered was 0.1 R/h, 53 hours after the detonation and 365 meters from ground zero (4; 55).

Project 2.5a-1, Airborne Particle Studies, was conducted by the Army Chemical Center. The objective was to determine characteristics of airborne particles associated with a surface detonation. Nine hours before the detonation, eight teams, each consisting of two personnel, finished checking air samplers in the shot area. Four hours after the area was opened for recovery operations, four teams, each having five project personnel and a monitor, retrieved samples from stations more than 4,270 meters northeast of ground zero. At 0730 on the next day, five parties, each of five personnel, recovered samples from stations 610 to 4,270 meters northeast of ground zero. Project 2.5a-3 personnel analyzed these samples (55; 60).

Project 2.5a-2, Fallout Particle Studies, was conducted by the Naval Radiological Defense Laboratory. The objective was to determine the chemical and physical properties and the distribution of fallout associated with a surface detonation (58).

Nine hours before the detonation, four two-man parties finished placing aerosol and fallout collectors in a sector northwest to northeast of ground zero at distances of 610 to 6,100 meters from ground zero. Three hours before the shot, four teams, each of two participants, and one group of nine participants began setting timers to activate the fallout trays five minutes before the shot. They spent about 45 minutes in this activity.

Thirty minutes after the detonation, a helicopter flew to the instrument area to pick up fallout trays with grappling hooks. The helicopter returned to a transfer station at an unspecified location. Project personnel then transported the trays by vehicle from the station to the Control Point. This operation continued until all samples had been retrieved. Two hours after the detonation, one participant transported the trays from the Control Point to the project center, probably at Camp Mercury. Four parties, each consisting of two participants and a monitor, retrieved earth samples two hours after the declaration of recovery hour. At 0730 hours on the day after the detonation, four two-man parties retrieved the remaining fallout trays (55; 58).

Project 2.5a-3, Radiochemical Studies of Large Particles, was conducted by the Army Medical Service Graduate School. The objective was to study the size, radioactivity, and chemical composition of fallout particles resulting from the detonation. Project personnel used samples from fallout trays located out to 23 kilometers northeast of ground zero. Project 2.5a-1 personnel collected these trays from the shot area, while Project 2.5a-3 personnel performed the analysis (48).

Project 2.6a, Remotely Controlled Sampling Techniques, was conducted by Evans Signal Laboratory and Coles Signal Laboratory. The objective was to obtain samples from the crater lip soon

after the detonation for radiochemical studies and spectrometer measurements. Samples were taken from areas around the crater and from about five meters within the crater using remotely controlled vehicles called weasels (25).

Nine hours before the detonation, six project personnel traveled to the shot area to set up two weasels. Sixteen participants left the Control Point three hours before the detonation to be eight kilometers from ground zero within an hour. An hour before the detonation, participants completed work on the sampling equipment.

Shortly after the detonation, project personnel, accompanied by a monitor, proceeded to a control tower, about 1,830 meters from ground zero, to conduct remotely controlled sampling for four and one-half hours. They then left for the Control Point. Thirty minutes later, they arrived at a checkpoint eight kilometers from ground zero. Participants left the weasels there and went to the Control Point for decontamination (25; 55).

Project 2.6c-1, Nature and Distribution of Residual Contamination I, was conducted by the National Institutes of Health and the Public Health Service. The objective was to determine the characteristics of radioactivity in the soil following the nuclear detonation, as a function of soil depth and distance. From one hour to 20 hours after the detonation, project participants took soil samples from the lip of the crater using remotely controlled weasels. In addition, personnel used retrievable rockets to collect one sample from the crater three days following the detonation after a period of considerable rain (46; 55).

Project 2.6c-2, Nature and Distribution of Residual Contamination II, was conducted by the Naval Radiological Defense Laboratory and the Evans Signal Laboratory. The experiment was

performed in conjunction with Project 2.6a. The objective was to determine the characteristics of radioactive soil samples. Two hours after the detonation, one participant went to the Project 2.6a unloading point to pick up the soil samples collected by the Project 2.6a weasels and deliver them to the Control Point. This same person repeated the procedure two hours later. Project 2.6c-2 personnel analyzed the soil samples collected by Project 2.6a participants (6; 55).

Project 2.6c-3, Retrievable Missiles for Remote Ground Sampling, was conducted by the National Institutes of Health and the Public Health Service. The objective was to develop and field-test an inexpensive method for obtaining soil samples from areas that personnel could not enter because of radiological conditions. On the afternoon of the second day after the detonation, project participants went to a location about 320 meters from ground zero and launched several rockets with attached lines. The rockets penetrated the soil in the crater and took samples on impact. Participants then dragged the rockets out of the area using the attached lines and returned the samples to the laboratory for analysis (47; 55).

Project 2.7, Biological Injury from Particle Inhalation, was conducted by the National Institutes of Health. The objective was to evaluate the inhalation of particles associated with a surface nuclear detonation. Four hours before the detonation, two teams, each of two persons, placed 12 sheep and 15 dogs at stations 760, 1,530, and 2,440 meters northeast of ground zero. They spent about 100 minutes in this activity. Four hours after the declaration of recovery hour, two groups, each of three project personnel and a monitor, recovered animals from the stations (55; 64).

Project 2.8, Analysis of Test Site and Fallout Material, was conducted by the Department of Agriculture, under contract to the

Atomic Energy Commission. The objective was to evaluate potential agricultural hazards from the fallout of a surface detonation. Before the shot and three days after, project personnel collected soil samples from small pits 30 meters west and a few meters south of ground zero and from a station 200 meters south of ground zero (1; 55).

Project 4.1, Aerial Technical Photography, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to produce technical and documentary films of physical phenomena associated with the shot. Project personnel at Wright-Patterson AFB, Ohio, outfitted three C-47 aircraft with special cameras and controls. The aircraft left Indian Springs AFB approximately 75 minutes before the detonation and entered their assigned orbits. At shot-time, the aircraft were positioned as follows: aircraft 1 was orbiting 10,000 feet due south of ground zero at an altitude of 10,000 feet; aircraft 2 was orbiting 10,000 feet west of ground zero at an altitude of 8,000 feet; aircraft 3 was orbiting an estimated 15,000 feet due south of ground zero at an altitude of 5,000 feet. Upon completing their mission, the aircraft returned to Indian Springs AFB to deliver film to the project officer (15; 55).

Project 4.1a-1, Ground Technical Photography Material Operation, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to document cloud formation (7).

Three hours before the detonation, participants started generators at photography stations located at the following distances from ground zero (7; 55):

- Two stations 4,570 meters southeast
- One station 3,000 meters northeast
- One station 2,740 meters east

- One station 2,440 meters northwest
- One station 1,520 meters southeast.

Two project participants and a monitor left the Control Point an hour after the declaration of recovery hour to recover film. Eight hours after the detonation, project participants returned the recovered film for development and analysis by Project 4.1a-2 personnel. At 0830 hours the next day, participants completed the recovery of film and sent it to Wright Air Development Center for processing (7; 55).

Project 4.1a-2, Photographic Analysis, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to analyze the photographs of crater development taken by Project 4.1a-1 personnel (49).

Project 4.2, Cratering Effects of Underground-surface Detonated Atomic Bombs and Influence of Soil Characteristics on Crater, was performed by the Naval Civil Engineering Research and Evaluation Laboratory. The project was to determine the precise dimensions of the crater. Project personnel took soil samples 15, 30, 60, and 90 meters from ground zero at radii of 45 degrees (9).

Project 6.1, Evaluation of Military Radiac Equipment, was conducted by the Evans Signal Laboratory and the Bureau of Ships. The purpose was to field-test radiac equipment. Four and one-half hours after the announcement of recovery hour, project personnel made a radiological survey of the Project 6.2 areas. Participants also accompanied radiological safety monitors as they surveyed the shot area (23; 55).

Project 6.2, Protection and Decontamination of Land Targets and Vehicles, was conducted by several agencies, including the Naval Radiological Defense Laboratory, the Engineer Research and Development Laboratories, the Army Chemical Center, and the

Office, Chief of Engineers. This project consisted of ten subprojects, seven of which were conducted at Shot SUGAR.

Land Reclamation by Surface Techniques was conducted by the Naval Radiological Defense Laboratory. The objectives were to determine the effectiveness of standard earth-moving techniques in reducing radiation in radioactively contaminated undeveloped land and to provide basic data for evaluating exposures of operating crews. Project personnel worked in radiation fields registering 0.06 to 0.3 R/h.

Land Reclamation by Barrier Techniques was conducted by the Engineer Research and Development Laboratories. This test was to measure the reduction of radiation intensity in areas protected by earth barriers within radioactive regions. Project personnel worked at locations 760 and 1,830 meters north of ground zero.

Decontamination of Paved Areas was conducted by the Chemical and Radiological Laboratories of the Army Chemical Center. The test evaluated various methods of decontaminating roads and other paved surfaces. Project personnel conducted operations 610 to 1,600 meters northwest of ground zero.

Decontamination of Construction Materials was performed by the Office, Chief of Engineers. The test was designed to determine the decontaminability of coated and uncoated surfaces of construction materials used by the Army Corps of Engineers. Following the shot, personnel subjected the materials to vacuum cleaning and high-pressure hosing. The materials were located 2,150 meters northeast of ground zero.

Contamination-Decontamination Phenomenology was conducted by the Naval Radiological Defense Laboratory. The objective was to study the effects of structure orientation and surface condition on the amount of contamination deposited and subsequently removed

in decontamination operations. Structures were located 920, 1,830, and 2,750 meters north to northeast of ground zero.

Decontamination of Vehicles was conducted by the Engineer Research and Development Laboratories. The purpose was to evaluate methods and techniques used to decontaminate military vehicles. Project personnel decontaminated trucks and tanks. The decontamination station was positioned at the boundary of the area in which personnel had to be accompanied by a radiological safety monitor.

Measurements were taken by the Naval Radiological Defense Laboratory to evaluate equipment and methods used to monitor the progress of decontamination operations. Personnel used survey meters and various air and surface sampling techniques for measurements in the other Project 6.2 experiments at SUGAR (18).

Project 6.3-1, Evaluation of Military Individual and Collective Protection Device and Clothing, was conducted by the Army Chemical Center. The objective was to determine the adequacy of protective equipment for use in radioactive areas. Project participants placed racks of protective clothing 300 to 600 meters northeast of ground zero. They also positioned two tanks with their hatches open 600 meters southeast of ground zero and placed clothing in the crew positions within the tanks. Two hours after the announcement of recovery hour, project personnel, accompanied by a monitor, retrieved protective equipment from the tanks (38; 55).

Project 6.3-2, Evaluation of Potential Respiratory Hazards Associated with Vehicular Operations in a Radioactively Contaminated Area, was performed by the Ballistics Research Laboratories, the Army Field Forces Board Number 2 Test Team, and the Army Chemical Center. The objectives were to gain data for

estimating the potential inhalation hazard faced by personnel in armored vehicles exposed to a nuclear detonation or operating in areas contaminated with fission fallout from a nuclear detonation. Two M26 tanks and one M59 personnel carrier were positioned in the shot area (20; 55).

Project 6.7, Clothing Decontamination and Evaluation of Laundry Methods, was conducted by the following:

- Detachment 7, 9135th Test Support Unit, Fort Lee, Virginia
- Office of the Quartermaster General
- Evans Signal Laboratory.

The main objective was to test the suitability of a laundry formula developed during Operation GREENHOUSE for the removal of radioactive contamination from clothing. A second objective was to field-test experimental survey instruments used to monitor levels of clothing contamination. Project personnel surveyed and washed the clothing used by personnel from Projects 6.2 and 6.3 (40).

Project 6.8, Evaluation of U.S. Army Field Water Supply Equipment and Operations, was conducted by the Engineer Research and Development Laboratories. The objective was to determine the resistance of water storage tanks to the blast and thermal effects of a surface nuclear detonation. In addition, the project investigated the potential problem of radioactive contamination of field water supplies following a surface detonation. Seventeen hours before the detonation, project personnel removed covers from water tanks that had been filled and placed at various distances at least 460 meters northeast of ground zero. Four hours after the announcement of recovery hour, project participants, accompanied by a monitor, retrieved samples from the water tanks (45; 55).

Project 7.1a, Transport of Radiation Debris, was conducted by Headquarters, Air Force, and the Air Weather Service. The objective was to determine the distribution of airborne debris from a nuclear detonation. Aircraft tracked the debris at various distances from the Nevada Proving Ground. Cloud tracking is described in section 2.2.3 of this chapter, which discusses Air Force support missions during Shot SUGAR (2).

Project 7.1b, Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris, was performed by Headquarters, Air Force, in conjunction with sampling operations conducted by the 4925th Test Group (Atomic). Project personnel made radiochemical analyses of nuclear weapon debris obtained close to the Nevada Proving Ground. Sampling operations are discussed in section 2.2.3 (63).

Project 7.2, Seismic Waves from A-Bombs Detonated over a Land Mass, was conducted by the 1009th Special Weapons Squadron, the Naval Ordnance Laboratory, the Acoustics Research Division of the Wright Air Development Center, and the Coast and Geodetic Survey. The objective was to study the seismic waves propagated by a nuclear detonation. Sixteen hours before the detonation, project personnel left six project stations located from 370 meters southwest to 24 kilometers north of ground zero. At 0830 hours on the day after the detonation, participants recovered seismic records from the six stations (16; 55).

Project 7.3, Airborne Low-frequency Sound from the Atomic Explosions during Operations BUSTER and JANGLE, was conducted by the Naval Electronics Laboratory, Signal Corps Engineering Laboratories, and National Bureau of Standards. The objective was to determine the range and reliability of acoustic detection equipment for continental nuclear explosions of various yields. Project personnel worked at stations in Alaska, California,

Florida, Hawaii, Kentucky, New Jersey, Texas, Washington, and Washington, D.C. (57).

2.2.2 Weapons Development Tests

The Weapons Development Test Unit conducted several projects at Shot SUGAR. Only one project, however, involved DOD participants: Project 10.4, Radiochemical Results. The Los Alamos Scientific Laboratory conducted this activity, the objective of which was to determine the particle makeup of the cloud resulting from the detonation. The project required cloud sampling, conducted by the 4925th Test Group (Atomic) (65). This activity is discussed in the next section.

2.2.3 Special Weapons Command Activities

The Special Weapons Command provided personnel to control air activities through the Air Operations Center of the NPG. SWC personnel conducted cloud-sampling, sample courier, and cloud-tracking missions and aerial surveys for the test units and the Test Manager (33).

The following list indicates the types and numbers of aircraft and the estimated numbers of DOD aircrew personnel involved in SWC missions at Shot SUGAR (21; 22; 28; 66):

ACTIVITY	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	NUMBER OF PERSONNEL
Sampling	B-29	2	16
Sample Courier Missions	B-25	1	5
Cloud Tracking	B-29	1	10
Aerial Surveys	C-47	3	15

Cloud Sampling

Two B-29s collected particulate samples of the Shot SUGAR cloud for Project 7.1b, Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris, and Project 10.4, Radiochemical Results. The B-29s left Indian Springs AFB about one hour before shot-time and orbited near Las Vegas until the detonation. The samplers flew at altitudes of 4,500 to 12,500 feet, made one or two penetrations of the cloud, and followed the cloud as far as 90 kilometers northeast of ground zero. The following gives additional details of the sampling mission (22):

AIRCRAFT TYPE AND SERIAL #	TOTAL TIME IN CLOUDS (seconds)	PEAK INTENSITY (R/h)	DOSIMETER READING (roentgens)
B-29 (386)	137	30	0.500
B-29 (599)	95	36	0.475

The dosimeter readings noted above indicate the cumulative exposures recorded by instruments such as film badges and pocket dosimeters within the aircraft.

Upon completing their mission, the samplers returned to Indian Springs AFB and parked in the aircraft decontamination area. Pilots then shut down the engines. The aircrews disembarked from the aircraft using the nose-wheel door. The sample-removing team used long-handled tools to remove the filter papers from the aircraft and place them in shielded containers. They then loaded the sample containers onto courier aircraft for delivery to laboratories for analysis (28; 66).

Courier Missions

After the sampling missions had been completed, one B-25 and other SWC aircraft left Indian Springs AFB on shot-day to transport filter papers and equipment to various laboratories

(primarily AEC and DOE facilities) for analysis. The 4901st Support Wing (Atomic) conducted these courier missions (33).

Cloud Tracking

After the detonation, one B-29 from Indian Springs AFB flew cloud-tracking missions over and beyond the Nevada Proving Ground for the test organization and Project 7.1a, Transport of Radiation Debris. The aircraft took off at 0730 hours, tracked the cloud at altitudes of 15,000 to 16,000 feet, and returned to base at 1830 hours (22).

Aerial Surveys

After the detonation, three C-47 aircraft, all based at Indian Springs AFB, conducted onsite and offsite survey missions to record radiation intensities for the test organization and Project 2.1c-1, Aerial Survey of Distant Contaminated Terrain. One C-47 flew 300 to 1,200 feet above the terrain from 1247 to 1527 hours. Another, flying 250 to 1,200 feet above the terrain, conducted its mission from 0750 to 1100 hours. The third C-47 flew 500 to 800 feet above the terrain from 1236 to 1514 hours. On the day after the shot, from 0817 to 1047 hours, the third C-47 flew a second mission at 500 to 800 feet over the same area to confirm its shot-day survey (22).

2.3 RADIOLOGICAL PROTECTION AT SHOT SUGAR

The primary purpose of the radiological protection procedures developed for members of Exercise Desert Rock, the test units, and SWC for Operation BUSTER-JANGLE was to keep individual exposure to ionizing radiation to a minimum, while still allowing participants to accomplish their missions. Information is available on monitoring and decontamination procedures at Shot SUGAR.

2.3.1 Desert Rock Radiological Protection Activities

For the exercise conducted by members of Desert Rock II and the evaluation teams, the Army devised plans and supplied personnel for radiological protection activities. AFSWP assisted the Army at Camp Desert Rock in these activities (61).

Dosimetry

The Radiological Safety Unit issued film badges and respirators to observers and Desert Rock personnel entering the area forward of the Control Point at Yucca Pass. After the completion of Desert Rock activities at the shot, radiological safety personnel collected most of the badges in the forward area before troops boarded vehicles for the return to Camp Desert Rock. They collected the remaining badges after participants returned to camp (37).

Monitoring

Survey teams monitored the shot area before the observers were permitted into the area. Radiological monitors accompanied observers on the buses transporting them into the shot area. One monitor remained at each display area to assist the damage effects teams, and at least one monitor accompanied each evaluation team (37).

Decontamination

Control stations were located on each road leading out of the shot area. Personnel and vehicles leaving the area were monitored at these stations. If gamma intensities exceeded 0.02 R/h, the personnel and vehicles were directed to the decontamination stations, located near the exercise area. Personnel were decontaminated mainly by dry brushing, showering, and laundering of clothes. Vehicle decontamination involved repeated washings with detergent and water (37).

2.3.2 Test Organization Radiological Protection Activities

The Radiological Health and Safety Group, consisting of personnel from LASL, from the armed services, and from various other civilian groups, developed procedures and conducted radiation protection activities at Shot SUGAR.

Dosimetry

Film badge records indicate that three personnel from the Engineer Research and Development Laboratories had total exposures of 3.3, 4.9, and 4.9 roentgens. The two individuals who received 4.9 roentgens were involved with Project 6.8 and may have been overexposed while collecting water samples from containers in the shot area. The project affiliation of the other Engineer Research and Development Laboratories participant is not known. One LASL participant had an exposure of 3.2 roentgens; his activities are not known (73).

Monitoring

The initial monitoring teams began their survey shortly after the detonation. They resurveyed the shot area several times during the next few days (62).

In addition to the ground survey teams, a team in a helicopter conducted an aerial survey of Area 9. This survey began about 20 minutes after the detonation. Approximately 40 minutes later, a second helicopter with one radiological safety monitor made another survey of Area 9, including all roads leading into the shot area.

After the teams completed the initial ground and aerial surveys, the Test Manager opened the shot area for recovery operations. Recovery parties, each accompanied by a radiological safety monitor, worked in the shot area from about 1100 to 1500 hours. They continued operations on subsequent days.

The Fallout Study of the Radiological Health and Safety Group provided monitoring 16 to 320 kilometers from ground zero. The study involved 32 personnel, one of whom was a DOD participant.

The three C-47 aerial survey aircraft provided offsite monitoring. The highest intensity detected offsite by the aerial survey teams was 0.0055 R/h (55; 62).

Plotting

Ground monitoring teams provided survey data used in plotting isointensity contours. Figure 2-3 presents an isointensity plot showing the results of a resurvey conducted 22 hours after the detonation (62).

Decontamination

Records indicate that 251 ground vehicles were decontaminated on 25 and 27 November (62). Data concerning vehicles and aircraft decontaminated during the preceding days are missing. As at the BUSTER shots, radiation levels were probably reduced to less than 0.002 R/h by repeated washings of the vehicles with detergent and water.

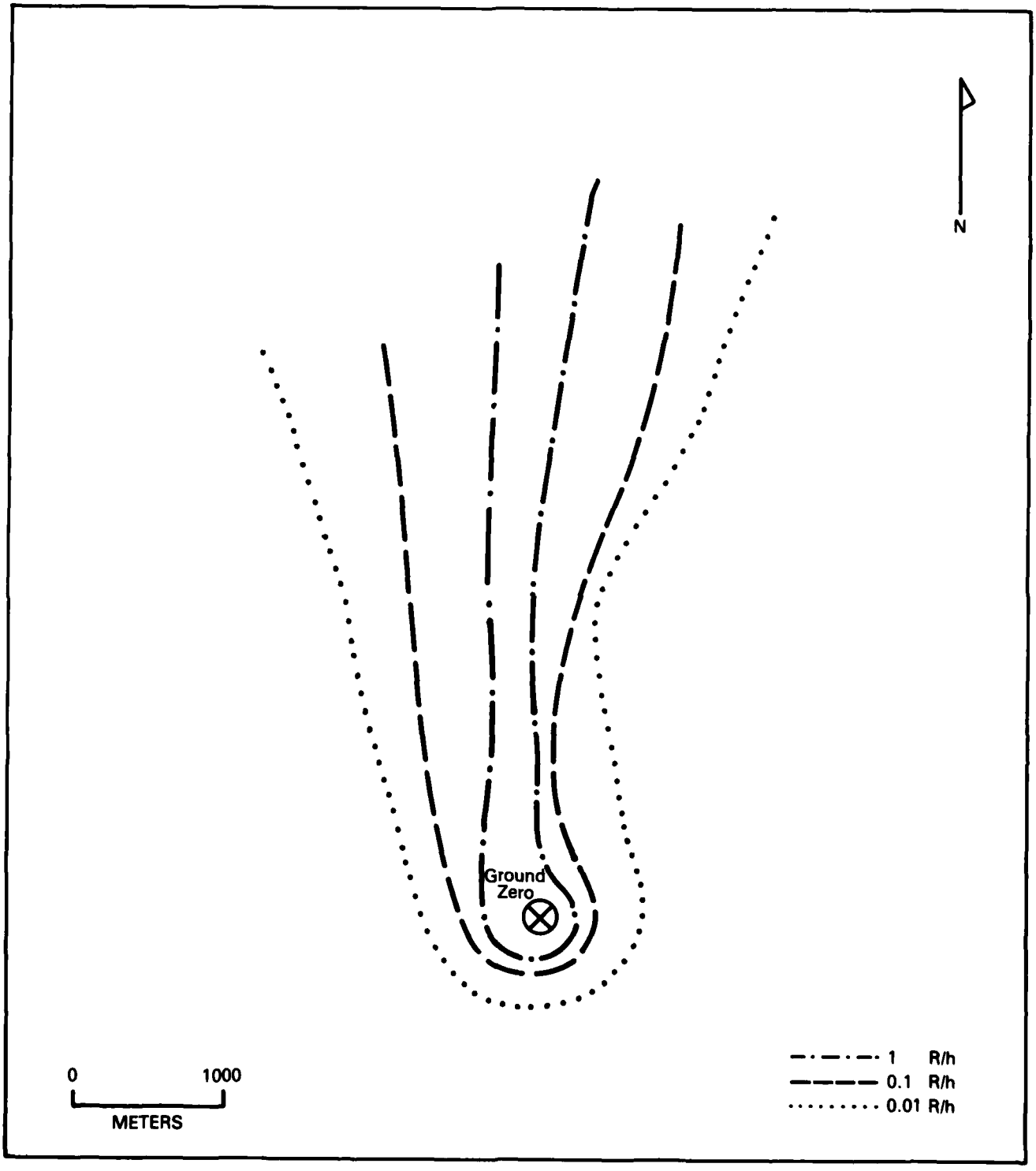


Figure 2-3: RESURVEY FOR SHOT SUGAR, 20 NOVEMBER 1951, 0700 HOURS

SHOT UNCLE SYNOPSIS

AEC TEST SERIES:	BUSTER-JANGLE
DOD EXERCISE:	Desert Rock III
DATE/TIME:	29 November 1951, 1200 hours
YIELD:	1.2 kilotons
HEIGHT OF BURST:	-17 feet (underground)

Purpose of Test: (1) Determine the militarily useful effects of underground nuclear detonations
(2) Evaluate equipment and techniques developed for military operations using nuclear weapons.

DOD Objective: To evaluate the utility of the nuclear device for military application; to instruct DOD personnel in the effects of a nuclear detonation.

Weather: At shot-time, the temperature was 14.5°C, the relative humidity was 35 percent, and the pressure was 872 millibars. The winds were two knots from the south at surface level, 15 knots from the south-southwest at 8,000 feet, and 21 knots from the southwest at 10,000 feet.

Radiation Data: Onsite fallout was relatively heavy north of ground zero. Nineteen hours after the shot, radiation intensities ranging from 2 R/h to 0.01 R/h stretched three kilometers northeast of ground zero, covering an area of about 10.5 square kilometers.

Participants: Los Alamos Scientific Laboratory; Exercise Desert Rock III troops; Special Weapons Command; Headquarters, Air Force; Naval Ordnance Laboratory; Air Force Cambridge Research Center; Air Weather Service; Signal Corps Engineering Laboratories; Air Research and Development Command; Naval Radiological Defense Laboratory; Army Chemical Center; Engineer Research and Development Laboratories; Naval Medical Research Institute; Naval Civil Engineering Research and Evaluation Laboratory; Ballistics Research Laboratories; Wright Air Development Center; contractors.

CHAPTER 3

SHOT UNCLE

Shot UNCLE, an underground nuclear detonation, was fired as scheduled at 1200 hours Pacific Standard Time on 29 November 1951 and had a yield of 1.2 kilotons. Developed by the Los Alamos Scientific Laboratory, the nuclear device was detonated 17 feet beneath the surface of Area 10 in Yucca Flat, UTM coordinates 850139. The Department of Defense and the Los Alamos Scientific Laboratory sponsored the shot. UNCLE was the first nuclear device fired underground by the United States.

The cloud resulting from Shot UNCLE, shown in figure 3-1, reached an altitude of 11,500 feet at its highest point. The cloud drifted northeast from the point of detonation. Onsite fallout occurred to the north and offsite fallout occurred to the north-northeast (27).

Shot UNCLE, like Shot SUGAR, was a weapons effects test, the last of the JANGLE phase of Operation BUSTER-JANGLE. The main purpose of the JANGLE tests was to determine the militarily useful effects of surface and underground nuclear detonations. Another objective was to evaluate equipment and techniques developed for military operations using nuclear weapons (4).

3.1 EXERCISE DESERT ROCK III OPERATIONS

Exercise Desert Rock III operations involved about 260 observers and evaluation team personnel at Shot UNCLE. Observer activities engaged 202 personnel from the Army. Six evaluation teams, each consisting of an estimated ten personnel, participated in tests of military equipment and field fortifications. Additional Camp Desert Rock troops, whose activities are

Figure 3-1: SHOT UNCLE, DETONATED AT 1200 HOURS ON 29 NOVEMBER 1951

discussed in the first part of this section, provided radiological safety, instruction, transportation, communications, and medical functions for Desert Rock activities in the forward area (8; 36).

3.1.1 Camp Desert Rock Personnel

Table 3-1 identifies the service units of Camp Desert Rock troops (37; 54). A minus (-) in a designation means that the unit was not fully represented. A plus (+) indicates that the unit was augmented with personnel from other units.

Camp Desert Rock personnel participating in Desert Rock activities at UNCLE gave administrative, logistical, and operational assistance to the observers and evaluation teams. In performing these duties, these troops sometimes entered the forward area. Three units particularly involved in shot-day operations were the Control Group, the Radiological Safety Unit, and the Advisory Group.

The Control Group, composed of members of the Camp Desert Rock staff sections, along with military police and signal personnel, accompanied the troops into the forward area. This group's duties were to supervise Desert Rock operations and to maintain contact with the Exercise Director.

The Radiological Safety Unit, directed by the Desert Rock Chemical Officer, implemented radiological safety criteria under the supervision of test organization personnel. Its duties included (37; 61):

- Issuing and collecting film badges
- Providing radiological safety monitors to supplement test organization monitors
- Conducting radiological surveys after the initial test organization survey

Table 3-1: SUPPORT UNITS ATTACHED TO CAMP DESERT ROCK, EXERCISE DESERT ROCK III

UNIT	HOME STATION
Headquarters	
Headquarters and Headquarters Battery, III Corps Artillery	Fort Lewis, Washington
Engineer	
231st Engineer Combat Battalion	Fort Lewis
359th Engineer Utility Detachment	Camp Cooke, California
Transportation	
Detachment, 4th Transportation Truck Company	Camp Stoneman, California
92nd Transportation Car Company	Camp Roberts, California
Detachment, 562nd Transportation Staging Company	Camp Stoneman
Military Police	
Company "C," 505th Military Police Battalion	Camp Roberts
Signal	
Detachment, Headquarters and Headquarters Company, 303rd Signal Service Battalion (+)	Camp Cooke
Detachment, Headquarters and Headquarters Company, Company "B," 314th Signal Construction Battalion (-)	Camp Cooke
Ordnance	
3623rd Ordnance Company	Camp Cooke
Quartermaster	
Detachment, 523rd Quartermaster Subsistence Depot Company (-)	Utah General Depot
Adjutant General	
806th Army Postal Unit	Fort Lewis

- Accompanying observers and evaluation teams on their postshot inspections of the equipment displays
- Establishing decontamination stations and procedures.

The Advisory Group, consisting of three officers from the Armed Forces Special Weapons Project, was assigned to Camp Desert Rock to provide technical assistance and advice to Desert Rock personnel. Before the shot, these officers instructed observers in nuclear weapons and their effects. After the detonation, they briefed the participants as they toured the equipment displays. In addition, they assisted the evaluation teams in assessing and then preparing reports on the effects of the detonation on the displays.

Besides the Control Group, the Radiological Safety Unit, and the Advisory Group, several other Desert Rock support elements engaged in activities before shot-day and on the day of detonation.

Prior to the shot, the 231st Engineer Combat Battalion spent about a week constructing field fortifications in the display areas. On shot-day, transportation personnel conveyed observers to a location 9.5 kilometers southwest of ground zero, where they witnessed the detonation. In the days after the detonation, the observers and evaluation teams were transported into the forward area to inspect the displays.

Military police provided traffic control in Camp Desert Rock and at the Nevada Proving Ground during the rehearsals conducted before shot-day, during the activities on the day of detonation, and on the following days.

Signal Corps personnel established wire and radio communications within the forward area, as well as at Camp Desert Rock. They also processed the film badges worn by participants in Desert Rock activities (37).

3.1.2 Observer Activities

At Shot UNCLE, 202 Army personnel took part in observer activities. The largest contingent of observers consisted of 135 individuals from Camp Desert Rock. Sixty-seven official observers were also from the Army (8; 36).

The observers took part in orientation and training activities to prepare for the event. In the days immediately preceding the detonation, instructors from the Advisory Group oriented the observers with films and lectures on the characteristics of a nuclear detonation and the procedures to follow during a nuclear test.

At approximately 0900 hours on 29 November, the observers left Camp Desert Rock in a vehicle convoy for the observer location, 9.5 kilometers southwest of ground zero. They arrived at the location, shown in figure 3-2, at about 1115 hours. Advisory Group instructors then conducted a brief preshot orientation. Shortly before the shot, the instructors directed the observers to sit on the ground with their backs toward ground zero.

After the initial flash of light from the detonation, which occurred at 1200 hours, the instructors directed observers to turn and view the fireball and cloud. Figure 3-3 shows the troops at the observation point watching Shot UNCLE. At about 1215, the observers began the return trip to Camp Desert Rock.

On 1 December, two days after the detonation, the observers toured the display areas in a bus convoy. Signal Corps personnel issued a film badge to each observer entering a bus. A radiological safety monitor from the Chemical Section accompanied each busload of observers (8; 37).

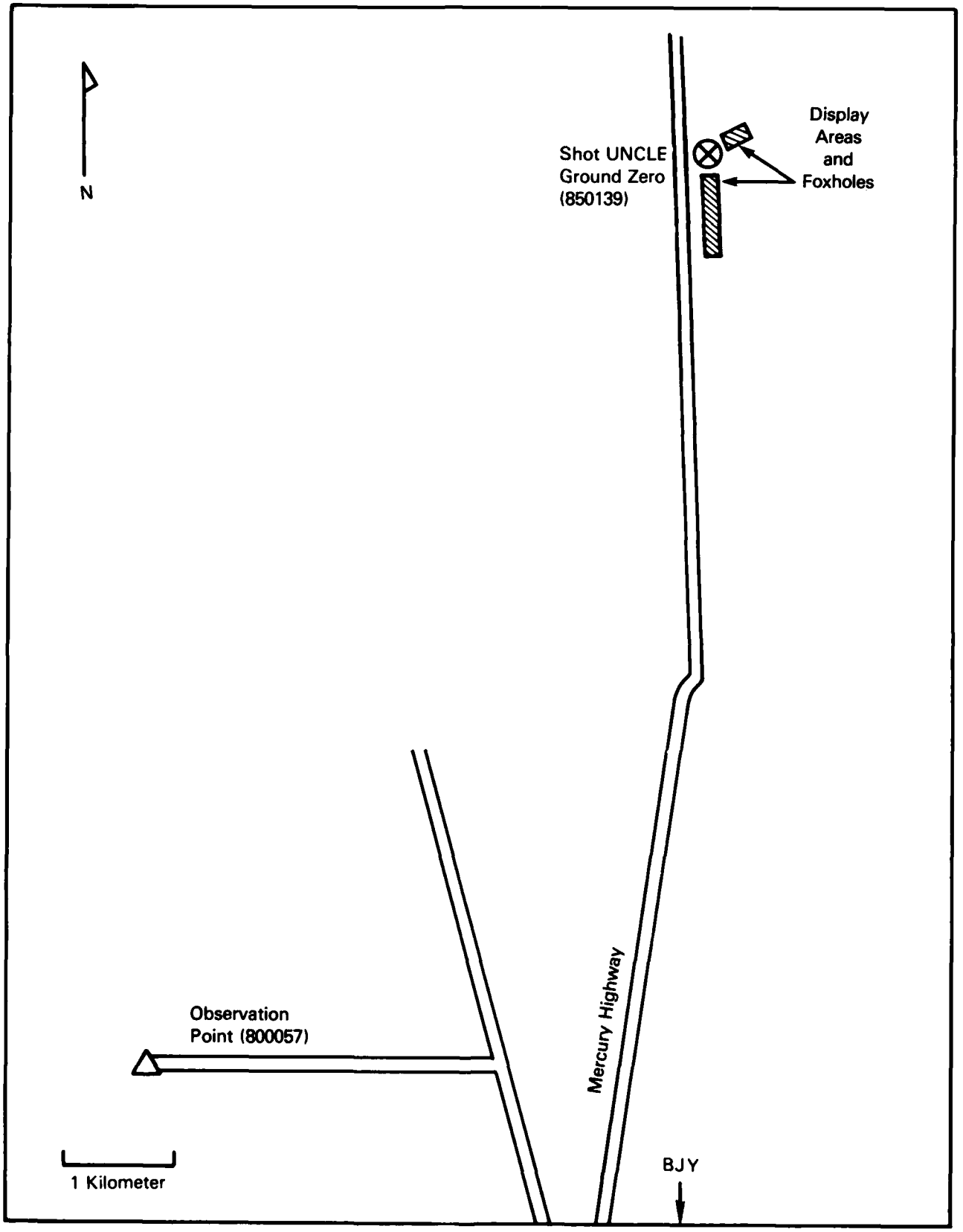


Figure 3-2: LOCATION OF DISPLAY AREAS, FOXHOLES, AND OBSERVATION POINT FOR EXERCISE DESERT ROCK III

Figure 3-3: TROOPS AT THE OBSERVATION POINT WATCHING SHOT UNCLE

Display areas were located 90 and 180 meters northeast of ground zero and 270 to 910 meters south of ground zero, as shown in figure 3-2. Interspersed among the displays were two rows of two-man foxholes. Along the northeast line of displays, the foxholes extended 90 to 610 meters from ground zero. Along the south line of displays, the foxholes extended 320 to 880 meters from ground zero. In addition, 46 test animals were placed along three arcs, 760, 1,530, and 2,440 meters north to northeast of ground zero. These animals were also used in Project 2.7 (37; 64).

Personnel remained on the buses as they traveled through the shot area. During the tour, Advisory Group instructors briefed the observers concerning the effects of the detonation on military equipment and foxholes. Radiation intensities in the area prevented the observers from viewing display areas to the northeast of ground zero and from viewing areas closer than 580 meters to the south of ground zero (8; 37).

3.1.3 Damage Effects Tests

Six evaluation teams studied the effects of the UNCLE detonation on military equipment and field fortifications. One team came from each of the following Camp Desert Rock sections: Chemical, Signal, Engineer, Medical, Ordnance, and Quartermaster. Each team was responsible for constructing equipment displays in the display areas, for recovering test equipment after the detonation, and for preparing a report of its findings.

For approximately one week before the detonation, the teams constructed their displays, with assistance from the 231st Engineer Combat Battalion. In addition, they instrumented the foxholes with film badges to indicate the radiation exposure personnel could have received had they been in the fortifications during the detonation.

The Officer in Charge, Effects Tests, posted a guard at each display position at 1600 hours three days before the shot. The guards were to keep unauthorized personnel out of the shot area and to see that no equipment or material was moved without the authority of the Officer in Charge. Personnel from Desert Rock S-3, Operations, relieved the guards during the night before the detonation. After the area was opened for recovery activities, the guards returned to the display positions, where they remained until relieved by the Officer in Charge (37).

Damage effects teams could not enter the display areas for several days because the light, changeable winds did not carry the cloud away from the ground zero area as fast as had been expected and because the underground detonation deposited considerable radiation around ground zero. Instead, the teams evaluated the damage by helicopter, making their first aerial inspection at 1600 hours on shot-day. One hour later, the Army Chief of Staff, accompanied by a radiological safety monitor, also made a helicopter tour of the display areas (37).

The first ground recovery operations probably began six hours after shot-time, when damage effects personnel recovered 18 test animals located farther from ground zero than the actual display areas. They retrieved the remaining 28 animals 24 hours after the detonation. Four days after the detonation, damage effects personnel wearing gas masks made a quick visual examination of the display area closest to ground zero to the northeast. Radiation intensities there were measured at 10 R/h. These positions were not fully examined until 23 January 1952, 55 days after the detonation (37).

Damage effects personnel began recovering film badges from the foxholes five days after the detonation. Seven days after the shot, personnel began retrieving test items from the display areas 270 to 910 meters south of ground zero. As radiation

levels decayed to safe levels, damage effects teams gradually expanded their examination and recovery of the test items until a thorough evaluation had been completed. The 231st Engineer Combat Battalion continued to remove equipment from the display areas until its departure from Camp Desert Rock on 14 December 1951 (37).

In preparing their reports, the evaluation teams received technical information from the Advisory Group. The LASL Graphic Arts Group provided them with photographs of the weapons effects tests for the reports (37).

3.2 DEPARTMENT OF DEFENSE PARTICIPATION IN SCIENTIFIC AND SUPPORT ACTIVITIES AT SHOT UNCLE

Department of Defense personnel took part in scientific experiments conducted at Shot UNCLE by the Weapons Effects Test Unit and the Weapons Development Test Unit. Table 3-2 lists the test unit projects by number and title and identifies the fielding organizations.

In addition to participating directly in test unit projects, DOD personnel provided support to the test units and the Test Manager. These activities involved about 650 DOD project personnel, 550 SWC air and ground personnel, and perhaps an additional 125 DOD personnel working for various units coordinated by the test organization.

3.2.1 Weapons Effects Tests

The Weapons Effects Test Unit conducted the projects at Shot UNCLE indicated in table 3-2. Project participants spent several weeks before the detonation placing and calibrating various types of instruments and gauges (4).

Table 3-2: TEST UNIT PROJECTS, SHOT UNCLE

Project	Title	Participants
	Weapons Effects Tests	
1.1	Ground Acceleration Measurement	Naval Ordnance Laboratory
1.2a-1	Peak Air Blast Pressures from Shock Velocity Measurements	Ballistics Research Laboratories
1.2a-2	Transient Ground Mechanical Effects from HE and Nuclear Explosions	Ballistics Research Laboratories
1.2b	Close-in Ground Measurements	Naval Special Weapons Unit (AFSWP)
1.3a	Free Air Shock Arrival Times	Brookhaven National Laboratory
1.3b	Peak Pressure versus Distance in Free Air Using Smoke and Rocket Photography	Naval Ordnance Laboratory
1.4	Free Air Pressure Measurements	Sandia Corporation
1.5a	Transient Ground Displacement Measurement	Naval Ordnance Laboratory
1.5b	Detection of Time of Arrival of First Earth Motion	David Taylor Model Basin
1.6	Earth Displacement (Shear Shafts)	Ohio River Division Laboratories; Office, Chief of Engineers
1.7	Ground Acceleration (Shock Pins)	Massachusetts Institute of Technology; Office, Chief of Engineers
1(8)b	Air Weather Service Participation in Operation JANGLE	2060th Mobile Weather Squadron
1(9)a	Ground Acceleration, Ground and Air Pressures for Underground Tests	Stanford Research Institute
1(9)b	Base Surge Analysis for Nuclear Tests	Naval Ordnance Laboratory
2.1a	Gamma Radiation as a Function of Time and Distance	Evans Signal Laboratory; National Bureau of Standards
2.1b	Gamma Radiation as a Function of Time with Droppable Telemeters	Naval Air Development Center
2.1c-1	Aerial Survey of Distant Contaminated Terrain	Headquarters, Air Force
2.1c-2	Aerial Survey of Local Contaminated Terrain	Bureau of Aeronautics; Air Research and Development Command; Wright Air Development Center
2.1d	Monitor Survey of Ground Contamination	Naval Radiological Defense Laboratory; Radiological Health and Safety Group of LASL; AFSWP
2.3-1	Total Gamma Radiation Dosage	Evans Signal Laboratory
2.3-2	Foxhole Shielding of Gamma Radiation	Engineer Research and Development Laboratories

Table 3-2: TEST UNIT PROJECTS, SHOT UNCLE (CONTINUED)

Project	Title	Participants
	Weapons Effects Tests (Continued)	
2.4a	Beta-ray and Gamma-ray Energy of Residual Contamination	Naval Radiological Defense Laboratory
2.4b	Gamma Depth Dose Measurement in Unit-density Material	Naval Medical Research Institute
2.4c	Gamma Ray Spectrum Measurements of Residual Radiation	Brookhaven National Laboratory
2.5a-1	Airborne Particle Studies	Army Chemical Center
2.5a-2	Fallout Particle Studies	Naval Radiological Defense Laboratory
2.5a-3	Radiochemical Studies of Large Particles	Army Medical Service Graduate School
2.6a	Remotely Controlled Sampling Techniques	Evans Signal Laboratory; Coles Signal Laboratory
2.6c-1	Nature and Distribution of Residual Contamination I	National Institutes of Health; Public Health Service
2.6c-2	Nature and Distribution of Residual Contamination II	Naval Radiological Defense Laboratory; Evans Signal Laboratory
2.6c-3	Retrievable Missiles for Remote Ground Sampling	National Institutes of Health; Public Health Service
2.7	Biological Injury from Particle Inhalation	National Institutes of Health
2.8	Analysis of Test Site and Fallout Material	Department of Agriculture
3.1	Navy Underground and Surface Structures	Bureau of Yards and Docks
3.2	Army Structures Test	Office, Chief of Engineers; Massachusetts Institute of Technology
3.3	Air Force Structures	Air Materiel Command; Armour Research Foundation
3.28	Structure Instrumentation	Sandia Corporation
3.29	Engineer Soil Mechanics Tests	Naval Civil Engineering Research and Evaluation Laboratory
4.1	Aerial Technical Photography	Wright Air Development Center
4.1a-1	Ground Technical Photography Material Operation	Wright Air Development Center
4.1a-2	Photographic Analysis	Wright Air Development Center
4.2	Cratering Effects of Underground-surface Detonated Atomic Bombs and Influence of Soil Characteristics on Crater	Naval Civil Engineering Research and Evaluation Laboratory
4.5	Characteristics of Missiles from Underground Nuclear Explosions	Stanford Research Institute
6.1	Evaluation of Military Radiac Equipment	Evans Signal Laboratory; Bureau of Ships
6.2	Protection and Decontamination of Land Targets and Vehicles	Naval Radiological Defense Laboratory; Engineer Research and Development Laboratories; Army Chemical Center; Office, Chief of Engineers

Table 3-2: TEST UNIT PROJECTS, SHOT UNCLE (CONTINUED)

Project	Title	Participants
Weapons Effects Tests (Continued)		
6.3-1	Evaluation of Military Individual and Collective Protection Device and Clothing	Army Chemical Center
6.3-2	Evaluation of Potential Respiratory Hazards Associated with Vehicular Operation in a Radioactively Contaminated Area	Ballistics Research Laboratories; Army Field Forces Board Number 2 Test Team; Army Chemical Center
6.4	Operational Tests of Techniques for Accomplishing IBDA	Wright Air Development Center
6.7	Clothing Decontamination and Evaluation of Laundry Methods	9135th Test Support Unit; Office of the Quartermaster General; Evans Signal Laboratory
6.8	Evaluation of U.S. Army Field Water Supply Equipment and Operations	Engineer Research and Development Laboratories
7.1a	Transport of Radiation Debris	Headquarters, Air Force; Air Weather Service
7.1b	Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris	Headquarters, Air Force; 4925th Test Group
7.2	Seismic Waves from A-Bombs Detonated over a Land Mass	1009th Special Weapons Squadron; Naval Ordnance Laboratory; Wright Air Development Center; Coast and Geodetic Survey
7.3	Airborne Low-frequency Sound from the Atomic Explosions during Operations BUSTER and JANGLE	Naval Electronics Laboratory; Signal Corps Engineering Laboratories; National Bureau of Standards
8.4	Technical Photography for IBDA Project	Lookout Mountain Laboratory
Weapons Development Tests		
10.4	Radiochemical Results	Los Alamos Scientific Laboratory

Project 1.1, Ground Acceleration Measurement, was conducted by the Naval Ordnance Laboratory. The principal objective was to study the characteristics of ground acceleration resulting from an underground detonation. Project participants placed accelerometers and pressure gauges at an estimated 16 stations located 60 to 930 meters south-southwest of the UNCLE ground zero. Four hours before the detonation, project personnel left the shot area after charging batteries in a recording station 2,480 meters south-southwest of ground zero. They recovered records from the station after the detonation (50; 55).

Project 1.2a-1, Peak Air Blast Pressures from Shock Velocity Measurements, was conducted by the Ballistics Research Laboratories. The objective was to study airblast effects in relation to ground shock effects. Blast switches and blast microphones were located along a radial line at nine unmanned stations, 90 to 470 meters south of ground zero. Recovery procedures were probably similar to those of Project 1.2a-2 (19; 55).

Project 1.2a-2, Transient Ground Mechanical Effects from HE [High Explosives] and Nuclear Explosions, was conducted by the Ballistics Research Laboratories. The objective was to measure ground shock phenomena. Project 1.2a-1 personnel also conducted this project. According to the AEC operation order, four participants and a monitor were to recover gauges from 12 stations 90 to 910 meters south of ground zero at 0730 hours on the day after the shot (3; 55).

Project 1.2b, Close-in Ground Measurements, was conducted by the Naval Special Weapons Unit, part of AFSWP. The objective was to measure, at close ranges, blast phenomena produced by an underground nuclear detonation. Participants placed blast gauges and pressure switches in holes 17 feet deep, the same depth at which UNCLE was detonated, at 31 stations 1.5 to 100 meters from ground zero. Electrical cables transmitted data from these gauges to a station about 2,400 meters from ground zero (26).

Three hours before the detonation, and after having installed blast gauges near ground zero, two participants arrived at the Program 1 telemetry station. The location of this station at Shot UNCLE has not been documented. At the declaration of recovery hour, two project personnel and a monitor left the telemetry station to recover blast records from the station 2,400 meters from ground zero (26; 55).

Project 1.3a, Free Air Shock Arrival Times, was conducted by Brookhaven National Laboratory. The objective was to measure the time of arrival of the blast wave in free air. Measurements were made with pressure gauges suspended from balloons (59).

Sixteen hours before the detonation, participants placed a timing unit, used to start a pressure recording system, near the UNCLE device. Six hours before the detonation, four project participants and seven workers began suspending gauges from balloons at a station 910 meters south of ground zero. An hour later, another participant arrived at the Program 1 telemetry station. Two hours and 15 minutes before the detonation, the four project participants at the balloon station proceeded to the telemetry station and the seven workers left the shot area. Participants left the telemetry station two hours after the detonation (55; 59).

Project 1.3b, Peak Pressure versus Distance in Free Air Using Smoke and Rocket Photography, was conducted by the Naval Ordnance Laboratory. The objective was to determine the peak overpressure along the ground and in the air above an underground detonation. Project personnel used high-speed photographs of smoke rocket trail distortions to measure blast pressures. Thirteen hours before the shot, three participants placed smoke rocket launchers at various locations in the shot area. They positioned the cameras 3,750 meters from ground zero (52; 55).

Project 1.4, Free Air Pressure Measurements, was conducted by Sandia Corporation. The objective was to record blast pressures at ground-level stations for an underground detonation. Before the detonation, project participants placed gauges around ground zero. Two hours before the detonation, two participants arrived at the Program 1 station eight kilometers west of ground zero. Four participants and a monitor retrieved blast records 520 to 950 meters from ground zero after the declaration of recovery hour (39; 55).

Project 1.5a, Transient Ground Displacement Measurement, was conducted by the Naval Ordnance Laboratory. The objective was to measure the transient ground displacement caused by an underground detonation and to correlate this displacement with ground acceleration and damage to structures. Before the shot, project personnel placed markers in the ground at ten stations 90 to 580 meters south of ground zero. In addition, they oriented a camera station, located 1,530 meters east of ground zero, toward the markers. During the detonation, the camera filmed the markers' movement resulting from the shot. Participants retrieved the film and measured marker displacement after the area was opened for recovery operations (51; 55).

Project 1.5b, Detection of Time of Arrival of First Earth Motion, was conducted by the David Taylor Model Basin. The objective was to obtain information on the time of the first detectable earth motion at each of ten stations located on a radial line 30 to 180 meters from ground zero. Before the detonation, project participants installed electric flash lamps at the ten stations and positioned a camera at a station 2,700 meters east of ground zero. During the detonation, the camera recorded the first earth motion at each station as the flash lamp was triggered by the earth motion. Participants retrieved film from the camera after the declaration of recovery hour (13; 55).

Project 1.6, Earth Displacement (Shear Shafts), was conducted by the Ohio River Division Laboratories and the Office, Chief of Engineers. The objective was to determine the limits and amounts of permanent displacement in areas surrounding craters caused by an underground detonation. Project participants installed instruments in a series of deep shafts 230 meters east and west and 300 meters south of ground zero. Several weeks later, they retrieved the data to determine permanent earth displacement (56).

Project 1.7, Ground Acceleration (Shock Pins), was conducted by the Massachusetts Institute of Technology and the Office, Chief of Engineers. The objective was to determine if shock pins would furnish reliable data regarding magnitude of the ground shock associated with a nuclear detonation. Before the detonation, project personnel installed metal shock pins two feet into the ground at stations located about 190 to 380 meters east and west of ground zero and 170 to 560 meters south of ground zero. Participants reentered the shot area after the declaration of recovery hour to examine the exterior of each shock pin station. Excavating crews later uncovered the shelters, enabling project personnel to photograph the positions of the shock pins (30; 55).

Project 1(8)b, Air Weather Service Participation in Operation JANGLE, was conducted by the 2060th Mobile Weather Squadron of the Air Weather Service. The activity was a continuation of Project 8.2, Air Weather Service Participation in Operation BUSTER. The objective, like that of Project 8.2, was to gather and report weather information before the detonation, including wind conditions, temperature, and humidity. Project personnel worked from a weather station at the Control Point and from outlying stations at Tonopah, Warm Springs, Currant, Pioche, and Alamo, Nevada, and at St. George, Utah (43).

Project 1(9)a, Ground Acceleration, Ground and Air Pressures for Underground Tests, was conducted by the Stanford Research Institute. The objectives were to:

- Obtain data for comparing the phenomena of an underground nuclear detonation with the phenomena resulting from high-explosive tests
- Provide measurements for Projects 1.1, 1.2a-2, and 1.4.

Two and one-half hours before the detonation, two participants left a blast gauge station 610 meters from ground zero. At the announcement of recovery hour, two project personnel and a monitor traveled to this station to recover blast records (17; 55).

Project 1(9)b, Base Surge Analysis for Nuclear Tests, was conducted by the Naval Ordnance Laboratory. The objective was to compare base surge data from an underground nuclear detonation with base surge data from underground high-explosive tests. In conducting the experiment, project personnel analyzed photographs of both UNCLE and the high-explosive tests (72).

Project 2.1a, Gamma Radiation as a Function of Time and Distance, was conducted by the Evans Signal Laboratory and the National Bureau of Standards. The objective was to measure gamma intensity in order to assess the radiation effects of an underground detonation. Nine hours before the detonation, eight project personnel finished checking radiation detectors 610 to 4,270 meters from ground zero. Most of the detectors were north-northwest to north-northeast of ground zero. Three hours and 30 minutes before the detonation, eight participants in two vehicles drove from the Control Point to a recorder station five kilometers west of ground zero. Four hours after the detonation, three participants relieved personnel who had gone to the recorder station shortly after shot-time. At 0800 hours on the day following the detonation, four personnel relieved the second

group of participants at the recorder station. At the same time, one participant and a radiological safety monitor surveyed some of the project stations (14; 55).

Project 2.1b, Gamma Radiation as a Function of Time with Droppable Telemeters, was conducted by the Naval Air Development Center. The objective was to measure the gamma intensity in and around the crater following the burst (11).

Fourteen hours before the detonation, two project participants installed telemetering instruments at eight-meter intervals 310 to 920 meters northeast of ground zero. The instruments transmitted data on shot-day to the Program 1 telemetry station. Project personnel entered the station several hours before the shot and operated equipment during the detonation and for 15 to 25 minutes thereafter.

The measurement of residual radiation involved a Navy P2V-2 aircraft that left Kirtland AFB for the Nevada Proving Ground one hour before the detonation. The aircraft had flown half the distance to the NPG by the time the nuclear device was detonated. Two hours after the detonation, the aircraft dropped radiac telemeter units into the crater area (11; 55).

Project 2.1c-1, Aerial Survey of Distant Contaminated Terrain, was conducted by Headquarters, Air Force. The objectives were to measure, by use of instrumented aircraft, the radiation levels of fallout from the cloud and to test the efficiency of various airborne instruments in detecting radioactivity. The aircraft involved in this project were under the operational control of SWC and are discussed in section 3.2.3 (31).

Project 2.1c-2, Aerial Survey of Local Contaminated Terrain, was conducted by the Navy Bureau of Aeronautics, Air Force Air

Research and Development Command, and Wright Air Development Center. The objective was to test the ability of airborne radiac equipment to detect gamma radioactivity on the ground (67).

After the detonation, two instrumented aircraft, a Navy P2V-2 and an Air Force B-17, orbited the NPG at altitudes of 8,000 feet and 10,000 feet, respectively. For an hour after the detonation, participants aboard the aircraft monitored and recorded radiation levels. After that, the aircraft surveyed the shot area at heights of 500 to 2,000 feet over the crater and its vicinity. Upon completing their mission, the aircraft returned to Kirtland AFB (55; 67).

Project 2.1d, Monitor Survey of Ground Contamination, was conducted by the Naval Radiological Defense Laboratory, the Radiological Health and Safety Group of LASL, and AFSWP. The objective was to determine the extent and magnitude of the radiation field in the shot area, as measured by survey teams. At various times up to one month after the detonation, the teams monitored radiation in the area. Radiological safety monitors accompanied the project monitors in their activities (42).

Project 2.3-1, Total Gamma Radiation Dosage, was conducted by the Evans Signal Laboratory. The objective was to use various types of dosimeters and film badges to determine gamma radiation exposure. Sixteen hours before the detonation, three teams, each consisting of two persons, placed dosimeters at about 100 stations 300 meters to 15 kilometers in various directions from ground zero. They recovered the dosimeters two days after the shot (24; 55).

Project 2.3-2, Foxhole Shielding of Gamma Radiation, was conducted by the Engineer Research and Development Laboratories. The objective was to evaluate the protection afforded by foxholes against gamma radiation emitted from an underground detonation.

Sixteen hours before the detonation, three teams, each consisting of two personnel, placed dosimeters in foxholes 610 to 1,530 meters northeast of ground zero. They recovered the dosimeters two days later (55; 70).

Project 2.4a, Beta-ray and Gamma-ray Energy of Residual Contamination, was conducted by the Naval Radiological Defense Laboratory. The objective was to determine the energy spectra of residual beta and gamma radiation. Before the shot, project personnel placed dosimeters at 13 stations 300 to 1,650 meters northwest of ground zero, at 19 stations 430 to 3,660 meters north of ground, at 11 stations 610 to 1,830 meters northeast of ground zero, and seven stations 910 to 2,010 meters south of ground zero.

Within three hours after the detonation, project personnel began recovering dosimeters at four stations located 910 to 1,460 meters south of ground zero. By five hours after the detonation, personnel had retrieved all the dosimeters northwest of ground zero except for the one closest to ground zero. Within 24 hours, personnel had retrieved all dosimeters northeast of ground zero, and within 50 hours after shot-time, they had retrieved all dosimeters north of ground zero, including the one located 300 meters northwest of ground zero. Recovery operations were not completed until 118 hours after the shot, when personnel retrieved dosimeters at three stations 1,650 to 2,010 meters south of ground zero (68; 74).

Project 2.4b, Gamma Depth Dose Measurement in Unit-density Material, was conducted by the Naval Medical Research Institute. The objective was to determine the dose from initial and residual gamma radiation. Twelve hours before the detonation, four project personnel placed instrumented phantoms, of masonite approximating the density of human tissue, 460 to 910 meters west and slightly south of ground zero. Four participants retrieved

the phantoms one hour after the announcement of recovery hour (12; 55).

Project 2.4c, Gamma Ray Spectrum Measurements of Residual Radiation, was conducted by Brookhaven National Laboratory. The objective was to determine the energy spectrum of residual gamma radiation resulting from an underground detonation. Two hours after the detonation, five project personnel and a monitor proceeded by truck to an area south of ground zero, where they took spectral measurements. Two hours after the detonation, they were 1,220 meters from ground zero, their closest approach on shot-day. The radiation intensity there was 0.08 R/h. Participants also took measurements 6, 28, 48, and 49 hours after the detonation. The highest intensity encountered was 0.45 R/h, 26 hours after the detonation and 3,350 meters downwind of ground zero (4; 55).

Project 2.5a-1, Airborne Particle Studies, was conducted by the Army Chemical Center. The objective was to determine characteristics of airborne particles associated with an underground detonation. Eight teams, each with two personnel, finished checking air samples in the shot area nine hours before the detonation. Four hours after the area was opened for recovery operations, four teams, each composed of five project personnel and a monitor, retrieved samples from stations more than 4,270 meters northeast of ground zero. At 0730 on the next day, five parties, each of five personnel, recovered samples from stations 610 to 4,270 meters northeast of ground zero. Project 2.5a-3 personnel analyzed these samples (55; 60).

Project 2.5a-2, Fallout Particle Studies, was conducted by the Naval Radiological Defense Laboratory. The objective was to determine the chemical and physical properties and the distribution of fallout associated with an underground detonation (58).

Nine hours before the detonation, four two-man parties finished placing aerosol and fallout trays in a sector northwest to northeast of ground zero at distances of 610 to 6,100 meters from ground zero. Three hours before the detonation, four teams, each of two participants, and one group of nine participants began setting timers to activate fallout trays five minutes before the shot. They spent about 45 minutes in this activity.

Thirty minutes after the detonation, a helicopter flew to the instrument area to pick up fallout trays with grappling hooks. The helicopter returned to a transfer station at an unspecified location. Project personnel transported the trays by vehicle from the station to the Control Point. This operation continued until all samples had been retrieved. Two hours after the detonation, one participant transported the trays from the Control Point to the project center, probably at Camp Mercury. Two hours after the declaration of recovery hour, four parties of two participants and a monitor retrieved earth samples. At 0730 hours on the day after the detonation, four parties of two persons each retrieved the remaining fallout trays (55; 58).

Project 2.5a-3, Radiochemical Studies of Large Particles, was conducted by the Army Medical Service Graduate School. The objective was to study the size, radioactivity, and chemical composition of fallout particles resulting from an underground detonation. Project personnel collected samples in fallout trays located out to 23 kilometers northeast of ground zero. Project 2.5a-1 personnel collected these trays from the shot area, and Project 2.5a-3 personnel performed the analysis (48).

Project 2.6a, Remotely Controlled Sampling Techniques, was conducted by Evans Signal Laboratory and Coles Signal Laboratory. The objective was to obtain samples from the crater lip soon after the detonation for radiochemical studies and spectrometer measurements. Samples were taken from areas around the crater

and from about five meters within the crater using remotely controlled vehicles called weasels (25).

Nine hours before the detonation, six project personnel traveled to the shot area to set up two weasels. Three hours before the detonation, 16 participants left the Control Point to be eight kilometers from ground zero within an hour. An hour before the detonation, participants completed work on the sampling equipment.

Shortly after the detonation, project personnel, accompanied by a monitor, proceeded to a control tower, about 1,830 meters from ground zero, to conduct remote-controlled sampling of the crater for four and one-half hours. The project personnel then left for the Control Point. Thirty minutes later, the party arrived at a checkpoint eight kilometers from ground zero. Participants left the weasels there and proceeded to the Control Point for decontamination (25; 55).

Project 2.6c-1, Nature and Distribution of Residual Contamination I, was conducted by the National Institutes of Health and the Public Health Service. The objective was to determine the characteristics of radioactivity in the soil following the nuclear detonation as a function of soil depth and distance. One day after the detonation, project participants took soil samples from the lip of the crater. In addition, personnel used retrievable rockets to obtain four samples from the crater two days after the shot (46; 55).

Project 2.6c-2, Nature and Distribution of Residual Contamination II, was conducted by the Naval Radiological Defense Laboratory and the Evans Signal Laboratory. The experiment was performed in conjunction with Project 2.6a. The objective was to determine the characteristics of radioactive soil samples. Two

hours after the detonation, one participant went to the Project 2.6a unloading point to pick up the soil samples collected by the Project 2.6a weasels and deliver them to the Control Point. This same person repeated this procedure two hours later. Project 2.6c-2 personnel analyzed the soil samples collected by Project 2.6a participants (6; 55).

Project 2.6c-3, Retrievable Missiles for Remote Ground Sampling, was conducted by the National Institutes of Health and the Public Health Service. The objective was to develop and field-test an inexpensive method for obtaining soil samples from areas that personnel could not enter because of radiological conditions. On the afternoon of the second day after the detonation, project participants went to a location about 320 meters from ground zero and launched several rockets with attached lines. The rockets penetrated the soil in the crater and took samples on impact. Participants then dragged the rockets out of the area, by the attached lines and returned the samples to the laboratory for analysis. Personnel repeated this procedure on the third day after the detonation (47; 55).

Project 2.7, Biological Injury from Particle Inhalation, was conducted by the National Institutes of Health. The objective was to evaluate the inhalation of particles associated with an underground detonation. Four hours before the detonation, two two-man teams placed 20 sheep and 26 dogs at stations 760, 1,530, and 2,440 meters north to northeast of ground zero. They spent about 100 minutes in this activity. Six hours after the detonation and again 24 hours after the detonation, two groups, each of three project personnel and a monitor, went to the stations to recover animals (55; 64).

Project 2.8, Analysis of Test Site and Fallout Material, was conducted by the Department of Agriculture, under contract to the Atomic Energy Commission. The objective was to evaluate potential agricultural problems related to the fallout from an

underground detonation. Before the shot and two days after, project personnel collected soil samples from small pits 45 meters north and 110 meters east of ground zero. They also collected samples from ground zero (1; 55).

Project 3.1, Navy Underground and Surface Structures, was conducted by the Bureau of Yards and Docks. The objectives were to:

- Determine the response of different precast concrete structures to blast pressures resulting from an underground detonation
- Determine the response of a light steel building and two types of communication towers to airblast
- Observe the effect of ground shock on standard utility installations and sections of pavement.

Test structures, instrumented with gauges to document blast pressures, strain, and displacement, were located south to southwest of ground zero. LASL personnel took documentary photographs of these structures before and after the detonation (34).

Project 3.2, Army Structures Test, was conducted by the Office, Chief of Engineers, and the Massachusetts Institute of Technology. The experiment tested eight structures to determine the dynamic loads produced by an underground detonation and to obtain data for the design of structures able to withstand the effects of such a detonation. One underground structure was constructed 70 meters from ground zero, and seven surface structures were located 130 to 270 meters from ground zero. All structures were instrumented to measure blast pressures, displacement, and strain. LASL personnel photographed the structures both before and after the detonation (29).

Project 3.3, Air Force Structures, was conducted by the Air Materiel Command and the Armour Research Foundation. The objective was to determine the ability of military, industrial, and commercial structures to withstand an underground detonation. The project tested 11 different structures, including reinforced concrete retaining walls and circular concrete cells. Project personnel placed the structures 100 to 320 meters from ground zero. They instrumented the structures with devices for measuring blast pressure, air pressure, and strain (5).

Project 3.28, Structure Instrumentation, was a designation for Sandia Corporation personnel who supported the structure projects conducted during the shot. These personnel installed instruments, operated the instruments by remote control during the detonation, and prepared records of the activities for other project teams (44).

Before the detonation, project personnel laid cables between test structures and shelters, installed power equipment, mounted relay and timer panels, tested and installed components, and calibrated systems for electronic and recording instruments. They completed their work one day before the detonation. At shot-time, they were working from facilities located near the structures and to the southwest of ground zero. After the declaration of recovery hour, participants collected data and retrieved test equipment (44; 55).

Project 3.29, Engineer Soil Mechanics Tests, was conducted by the Naval Civil Engineering Research and Evaluation Laboratory. The project was designed to determine the characteristics, properties, and behaviors of the soil types in the vicinity of the detonation. Several weeks after the shot, project personnel made 57 soil borings in the vicinity of ground zero. Fourteen of these borings were within a radius of 90 meters of ground zero. To obtain soil profiles, project personnel conducted laboratory analyses of the samples (10; 55).

Project 4.1, Aerial Technical Photography, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to provide technical and documentary films of physical phenomena associated with the shot. Project personnel at Wright-Patterson AFB outfitted three C-47 aircraft with special cameras and controls for the activity. The aircraft left Indian Springs AFB approximately 75 minutes before the detonation and entered their assigned orbits. At shot-time, the aircraft were positioned as follows: aircraft 1 was orbiting 10,000 feet due south of ground zero at an altitude of 10,000 feet; aircraft 2 was orbiting 10,000 feet west of ground zero at an altitude of 8,000 feet; and aircraft 3 was orbiting an estimated 15,000 feet due south of ground zero at an altitude of 5,000 feet. Upon completion of the mission, the aircraft returned to Indian Springs AFB to deliver film to the project officer (15; 55).

Project 4.1a-1, Ground Technical Photography Material Operation, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to document blast damage phenomena and crater development (7).

Three hours before the detonation, participants started generators at photography stations located at the following distances from ground zero (7; 55):

- Two stations 4,570 meters southwest
- One station 4,270 meters southeast
- One station 3,000 meters northeast
- One station 2,740 meters southeast
- One station 1,520 meters southeast
- One station 1,460 meters southeast
- One station 1,370 meters southeast
- One station 640 meters south.

Two project participants and a monitor left the Control Point an hour after the declaration of recovery hour to recover film,

proceeding as radiological conditions permitted. Eight hours after the detonation, project participants returned the recovered film for development and analysis to Project 4.1a-2 personnel. At 0830 hours the next day, participants finished recovering the film and sent it for processing to Wright Air Development Center (7; 55).

Project 4.1a-2, Photographic Analysis, was conducted by the Technical Photographic Service Branch of the Wright Air Development Center. The objective was to analyze the Project 4.1a-1 photographs of crater development (49).

Project 4.2, Cratering Effects of Underground-surface Detonated Atomic Bombs and Influence of Soil Characteristics on Crater, was performed by the Naval Civil Engineering Research and Evaluation Laboratory. The project was to determine the precise dimensions of the crater. Project personnel obtained soil samples 15, 30, 60, and 90 meters from ground zero at radii of 45 degrees (9).

Project 4.5, Characteristics of Missiles from Underground Nuclear Explosions, was conducted by the Stanford Research Institute. The objective was to obtain data on the damage produced by debris projected by a nuclear detonation. At least 28 days before the test, project personnel constructed several concrete highway strips and an array of walls. The highway strips each contained a specific substance, such as aluminum nails or crushed red brick. Project participants laid out the highway slabs at distances of five to 90 meters west of ground zero. They built the wall sections on a different line extending six to 16 meters from ground zero. After the detonation, they tracked down the fragmentary missiles and recorded the direction and distances traveled (55; 69).

Project 6.1, Evaluation of Military Radiac Equipment, was conducted by the Evans Signal Laboratory and the Bureau of Ships. The purpose was to field-test radiac equipment. Four and one-half hours after the announcement of recovery hour, project personnel surveyed radiation levels in the Project 6.2 areas. Participants also accompanied radiological safety monitors as they surveyed the shot area (23; 55).

Project 6.2, Protection and Decontamination of Land Targets and Vehicles, was conducted by several agencies, including the Naval Radiological Defense Laboratory, the Engineer Research and Development Laboratories, the Army Chemical Center, and the Office, Chief of Engineers. This project consisted of ten subprojects, eight of which were conducted at Shot UNCLE.

Flame Decontamination was conducted by the Naval Radiological Defense Laboratory. This experiment involved testing a flame decontamination unit on surfaces of wood, asphalt, and concrete. These surfaces were at two locations, 800 and 1,600 meters north-northwest and west of ground zero.

Decontamination of Paved Areas was conducted by the Army Chemical Center. The purpose was to evaluate various methods for decontaminating roads. The roads were 620 to 1,600 meters northwest of ground zero.

Decontamination of Test Structures was conducted by the Naval Radiological Defense Laboratory. The test was designed to determine the effectiveness of three methods for decontaminating buildings: water washing with a fire hose; hot liquid cleaning with a mixture of steam, hot water, and detergent; and vacuum cleaning.

Decontamination of Construction Materials was conducted by the Office of the Chief of Engineers. The test was designed to

determine the decontaminability of coated and uncoated surfaces of construction materials used by the Army Corps of Engineers. Following the shot, personnel subjected these surfaces to vacuum cleaning and high-pressure hosing. These surfaces were located 2,150 meters northeast of ground zero.

Contamination-Decontamination Phenomenology was conducted by the Naval Radiological Defense Laboratory. The objective was to study the effects of structure orientation and surface condition on the amount of contamination deposited and subsequently removed in decontamination operations. Structures were located 1,830 and 2,745 meters north to northeast of ground zero.

Test of Materials was conducted by the Chemical and Radiological Laboratory of the Army Chemical Center. The purpose was to study the decontaminability of materials commonly used for military purposes. Panels of various materials were exposed at locations 1.6 to 22 kilometers north to northeast of ground zero.

Decontamination of Vehicles was conducted by the Engineer Research and Development Laboratories. The purpose was to evaluate methods and techniques used to decontaminate military vehicles. Two M26 tanks were exposed 620 meters from ground zero. In addition, trucks were exposed. These vehicles were decontaminated at a station located at the boundary of the area in which personnel had to be accompanied by a radiological safety monitor. Figure 3-4 shows a project participant decontaminating a tank.

Measurements were taken by the Naval Research and Development Laboratory to evaluate equipment and methods used to monitor the progress of decontamination operations as these operations occurred in the other Project 6.2 experiments at UNCLE (18).

Figure 3-4: PROJECT 6.2 TANK DECONTAMINATION

Project 6.3-1, Evaluation of Military Individual and Collective Protection Device and Clothing, was conducted by the Army Chemical Center. The objective was to determine the adequacy of protective equipment for use in radioactive areas. Project participants placed racks of protective clothing in the forward area. They also positioned two tanks with their hatches open and placed clothing in the crew positions within the tanks. Two hours after the announcement of recovery hour, project personnel, accompanied by a monitor, recovered protective equipment from the tanks (38; 55).

Project 6.3-2, Evaluation of Potential Respiratory Hazards Associated with Vehicular Operation in a Radioactively Contaminated Area, was performed by the Ballistics Research Laboratories, the Army Field Forces Board Number 2 Test Team, and the Army Chemical Center. The objectives were to gain data to use in estimating the potential inhalation hazard faced by personnel in armored vehicles exposed to a nuclear detonation or operating in areas contaminated with fission fallout from a nuclear detonation. Two M26 tanks and one M59 personnel carrier were positioned in the shot area (20; 55).

Project 6.4, Operational Tests of Techniques for Accomplishing Indirect Bomb Damage Assessment, was conducted by the Wright Air Development Center. The objective was to test, under operational conditions, radar and photography equipment as a means of determining the ground zero and yield of a nuclear detonation. Three hours and 45 minutes before the detonation, two B-50s and a B-29 left Kirtland AFB to be in position at shot-time, about eight kilometers south, southeast, and north, respectively, of ground zero. After the detonation the aircraft, instrumented with radar equipment and cameras, took photographs and recorded data. The aircraft then returned to Kirtland AFB (41; 55).

Project 6.7, Clothing Decontamination and Evaluation of Laundry Methods, was conducted by the following:

- Detachment 7, 9135th Test Support Unit, Fort Lee, Virginia
- Office of the Quartermaster General
- Evans Signal Laboratory.

The main objective was to test the suitability of a laundry formula developed during Operation GREENHOUSE for the removal of radioactive contamination from clothing. A second objective was to field-test experimental survey instruments used to monitor levels of clothing contamination. Project personnel surveyed and washed the clothing used by personnel from Projects 6.2 and 6.3 (40).

Project 6.8, Evaluation of U.S. Army Field Water Supply Equipment and Operations, was conducted by the Engineer Research and Development Laboratories. The objective was to determine the resistance of water storage tanks to the blast and thermal effects of an underground detonation. In addition, the project investigated the potential problem of radioactive contamination of field water supplies following an underground detonation. No water tanks were used at Shot UNCLE. However, personnel from Project 2.8, Analysis of Test Site and Fallout Material, collected ground contamination data. Using these data, Project 6.8 personnel calculated the contamination levels that water in tanks would have shown had there been tanks in the fallout path (45; 55).

Project 7.1a, Transport of Radiation Debris, was conducted by Headquarters, Air Force, and the Air Weather Service. The objective was to determine the distribution of airborne debris from a nuclear detonation. Aircraft tracked the debris at various distances from the Nevada Proving Ground. Cloud tracking is described in section 3.2.3 of this chapter, which discusses Air Force support missions during Shot UNCLE (2).

Project 7.1b, Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris, was performed by Headquarters, Air Force, in conjunction with sampling operations conducted by the 4925th Test Group (Atomic). Project personnel made radiochemical analyses of nuclear weapon debris obtained close to the Nevada Proving Ground. Sampling operations are discussed in section 3.2.3 (63).

Project 7.2, Seismic Waves from A-Bombs Detonated over a Land Mass, was conducted by the 1009th Special Weapons Squadron, the Naval Ordnance Laboratory, the Acoustics Research Division of the Wright Air Development Center, and the Coast and Geodetic Survey. The objective was to study the seismic waves propagated by a nuclear detonation. Sixteen hours before the detonation, project personnel left six project stations located from 370 meters southwest of ground zero to 24 kilometers north of ground zero. Participants recovered seismic records from the six stations at 0830 hours on the day after the detonation (16; 55).

Project 7.3, Airborne Low-frequency Sound from the Atomic Explosions during Operations BUSTER and JANGLE, was conducted by the Naval Electronics Laboratory, Signal Corps Engineering Laboratories, and National Bureau of Standards. The objective was to determine the range and reliability of acoustic detection equipment for continental nuclear explosions of various yields. Project personnel worked at stations in Alaska, California, Florida, Hawaii, Kentucky, New Jersey, Texas, Washington, and Washington, D.C. (57).

Project 8.4, Technical Photography for IBDA Project, was conducted by the Air Force Lookout Mountain Laboratory. The purpose was to provide technical and documentary photography of Project 6.4, Operational Tests of Techniques for Accomplishing Indirect Bomb Damage Assessment. Lookout Mountain Laboratory personnel photographed the indirect bomb damage assessment

mission from the one B-29 and two B-50 aircraft that performed Project 6.4. At the time of the detonation, the B-29, operated by personnel from the Armament Test Division of Eglin AFB, Florida, was five kilometers due south of ground zero at 17,000 feet. One B-50 flew at the same altitude right behind the B-29. The second B-50 was five kilometers due north of ground zero at 20,000 feet. The 4925th Test Group (Atomic) probably operated the B-50s. All three aircraft staged out of Kirtland AFB (4; 33; 41).

3.2.2 Weapons Development Tests

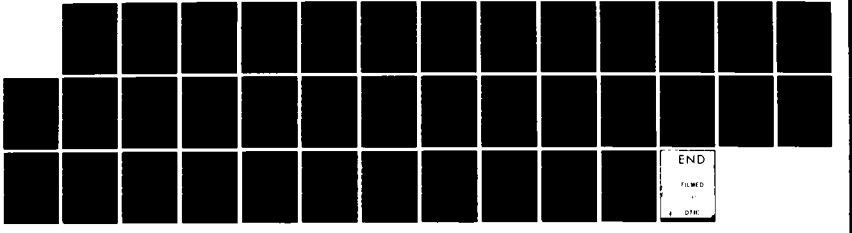
The Weapons Development Test Unit conducted several projects at Shot UNCLE. Only one project, however, involved DOD participants: Project 10.4, Radiochemical Results. Conducted by LASL, this experiment was designed to determine the particle makeup of the cloud resulting from Shot UNCLE. The project required cloud sampling, which was conducted by the 4925th Test Group (Atomic) (65). This activity is discussed in the next section.

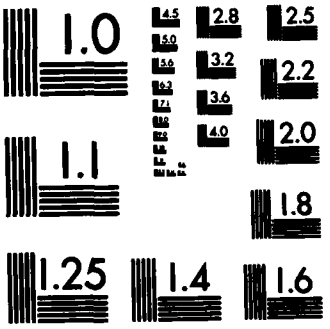
3.2.3 Special Weapons Command Activities

The Special Weapons Command provided personnel to control air activities through the Air Operations Center, which coordinated air traffic over the Nevada Proving Ground. SWC personnel conducted cloud-sampling, sample courier, and cloud-tracking missions and aerial surveys for the test units and the Test Manager (33).

The following listing indicates the types and numbers of aircraft and the estimated numbers of DOD aircrew personnel involved in SWC missions at Shot UNCLE (21; 22; 28; 66):

AD-A122 243 SHOTS SUGAR AND UNCLE THE FINAL TESTS OF THE 2/2
BUSTER-JANGLE SERIES 19 NOVE.. (U) JRB ASSOCIATES INC
MCLEAN VA J PONTON ET AL. 23 JUN 82 DNA-6025F
UNCLASSIFIED DNA001-79-C-0473 F/G 15/6 NL





ACTIVITY	TYPE OF AIRCRAFT	NUMBER OF AIRCRAFT	NUMBER OF PERSONNEL
Sampling	B-29	2	16
Sample Courier Missions	B-25	1	5
Cloud Tracking	B-29	1	10
Aerial Surveys	C-47	3	15

Cloud Sampling

Two B-29s collected particulate and gaseous samples of the cloud for Project 7.1b, Radiochemical, Chemical, and Physical Analysis of Atomic Bomb Debris, and Project 10.4, Radiochemical Results. The B-29s left Indian Springs AFB about three hours before shot-time and orbited near Las Vegas until the detonation. The samplers flew at altitudes of 5,500 to 10,000 feet, made up to seven penetrations of the cloud, and traveled up to 100 kilometers northeast of ground zero. The following gives further details of the sampling missions (22):

AIRCRAFT TYPE AND SERIAL #	TOTAL TIME IN CLOUDS (seconds)	PEAK INTENSITY (R/h)	DOSIMETER READING (roentgens)
B-29 (386)	780	4.4	0.340
B-29 (599)	465	2.0	0.040

The dosimeter readings noted above indicate the cumulative exposures recorded by instruments, such as film badges and pocket dosimeters, within the aircraft.

Upon completing their mission, the samplers returned to Indian Springs AFB and parked in the aircraft decontamination area. Pilots then shut down the engines. The aircrews disembarked from the aircraft using the nose-wheel door. The sample-removing team used long-handled tools to remove the filter papers and place them in shielded containers. They then loaded the sample containers onto courier aircraft for delivery to laboratories for analysis (28; 66).

Courier Missions

After the sampling missions had been completed, one B-25 and other SWC aircraft left Indian Springs AFB on shot-day to transport filter papers and equipment to various laboratories (primarily AEC and DOD facilities) for analysis. The 4901st Support Wing (Atomic) conducted these courier missions (33).

Cloud Tracking

After the detonation, one B-29 from Indian Springs AFB flew a cloud-tracking mission over and beyond the Nevada Proving Ground for the test organization and for Project 7.1a, Transport of Radiation Debris. The aircraft tracked the cloud at altitudes ranging from 14,000 to 16,000 feet (22).

Aerial Surveys

Three C-47 aircraft, all based at Indian Springs AFB, conducted onsite and offsite survey missions to record radiation intensities for the test organization and Project 2.1c-1, Aerial Survey of Distant Contaminated Terrain. The missions, planned for 29 November 1951, were postponed because of a delay in shot-time and the slow-moving, low-level cloud. The C-47s conducted their mission on 30 November. The first aircraft flew at heights of 400 to 700 feet above the terrain from 0750 to 1058 hours. The second flew at heights of 70 to 1,000 feet from 0804 to 1044 hours. The third C-47 flew at heights of 500 to 1,100 feet from 0753 to 1053 hours (22).

3.3 RADIOLOGICAL PROTECTION AT SHOT UNCLE

The primary purpose of the radiological protection procedures developed for members of Exercise Desert Rock, the test units, and SWC for Operation BUSTER-JANGLE was to keep individual exposures to ionizing radiation to a minimum, while still allowing participants to accomplish their missions. Information on radiological safety at Shot UNCLE includes data on monitoring and decontamination procedures.

3.3.1 Desert Rock Radiological Protection Activities

For the exercise conducted by members of Desert Rock III and the evaluation teams, the Army planned and supplied personnel for radiation protection activities. AFSWP assisted the Army at Camp Desert Rock in these activities (61).

Dosimetry

The Radiological Safety Unit issued film badges and respirators to observers and Desert Rock personnel entering the area forward of the Control Point at Yucca Pass. After the completion of Desert Rock activities at the shot, radiological safety personnel collected most of the badges in the forward area before troops boarded vehicles for the return to Camp Desert Rock. They collected the remaining badges after the troops returned to camp (37).

Records indicate that three Desert Rock personnel received gamma exposures exceeding 3 roentgens while at UNCLE. Their exposures were 4.7, 4.9, and 5.8 roentgens (73).

Monitoring

Survey teams monitored the shot area before the observers were permitted into the area. Radiological monitors accompanied observers on the buses transporting them into the shot area. One

monitor remained at each display area to assist the damage effects teams, and at least one monitor accompanied each evaluation team (37).

Decontamination

Control stations were located on each road leading out of the shot area. Personnel and vehicles leaving the area were monitored at these stations. If gamma intensities exceeded 0.02 R/h, the personnel and vehicles were directed to the decontamination facility near the exercise area. Personnel were decontaminated mainly by dry brushing, showering, and laundering of clothes. Vehicle decontamination involved repeated washings with detergent and water (37).

3.3.2 Test Organization Radiological Protection Activities

The Radiological Health and Safety Group, consisting of personnel from LASL, from the armed services, and from various other civilian groups, planned and conducted radiation protection activities at Shot UNCLE.

Dosimetry

Film badge records indicate that seven personnel from the Radiological Health and Safety Group who participated in Shot UNCLE had total gamma exposures over 3 roentgens. Their exposures ranged from 3 to 3.5 roentgens. One participant from Evans Signal Laboratory received a total exposure of 5.7 roentgens. Three Navy personnel received total exposures of 3.1, 3.2, and 3.5 roentgens (23; 25; 73).

Several Air Force personnel received gamma exposures that put them over the 3 roentgen limit: one participant from the 97th Bombardment Squadron received 3.1 roentgens; one participant from Lackland AFB, Texas, received 3.6 roentgens; one AFSWP

participant received 3.8 roentgens; and one Technical Operations Squadron participant received 5 roentgens. In addition, one participant whose unit is identified as BUSTER-JANGLE in the film badge records had an exposure of 4.7 roentgens (73).

Monitoring

The initial monitoring teams began their survey soon after the detonation. They resurveyed the shot area during the next several days. In addition to the ground survey teams, a team in a helicopter conducted an aerial survey of Area 10, including all roads leading into the shot area (62).

After the teams completed the initial ground and aerial surveys, the Test Manager opened the shot area for limited recovery operations. Recovery parties, each accompanied by a radiological safety monitor, worked in the shot area from about 1330 to 1800 hours. They continued operations on subsequent days.

The Fallout Study of the Radiological Health and Safety Group provided monitoring 16 to 320 kilometers from ground zero. The study involved 32 personnel, one of whom was a DOD participant. As the study team noted, the Shot UNCLE cloud moved to the northeast and "seemed to hang in the valleys." Study personnel also observed that the wind reversed direction late in the afternoon of shot-day, and fallout "returned and passed directly over the CP" [Control Point]. The filter papers that collected some of the fallout became "too hot to count even on the following day" (102).

The three C-47 terrain survey aircraft provided offsite monitoring. The aerial survey teams found maximum surface gamma intensities lower than 0.02 R/h in all offsite areas surveyed (55; 62).

Plotting

Ground monitoring teams provided survey data used in plotting isointensity contours. Figure 3-5 presents an isointensity plot showing the results of a resurvey conducted 19 hours after the detonation (62).

Decontamination

Records indicate that 275 ground vehicles were decontaminated during UNCLE (62). As at the BUSTER shots, radiation levels were probably reduced to less than 0.002 R/h by repeated washings of the vehicles with detergent and water.

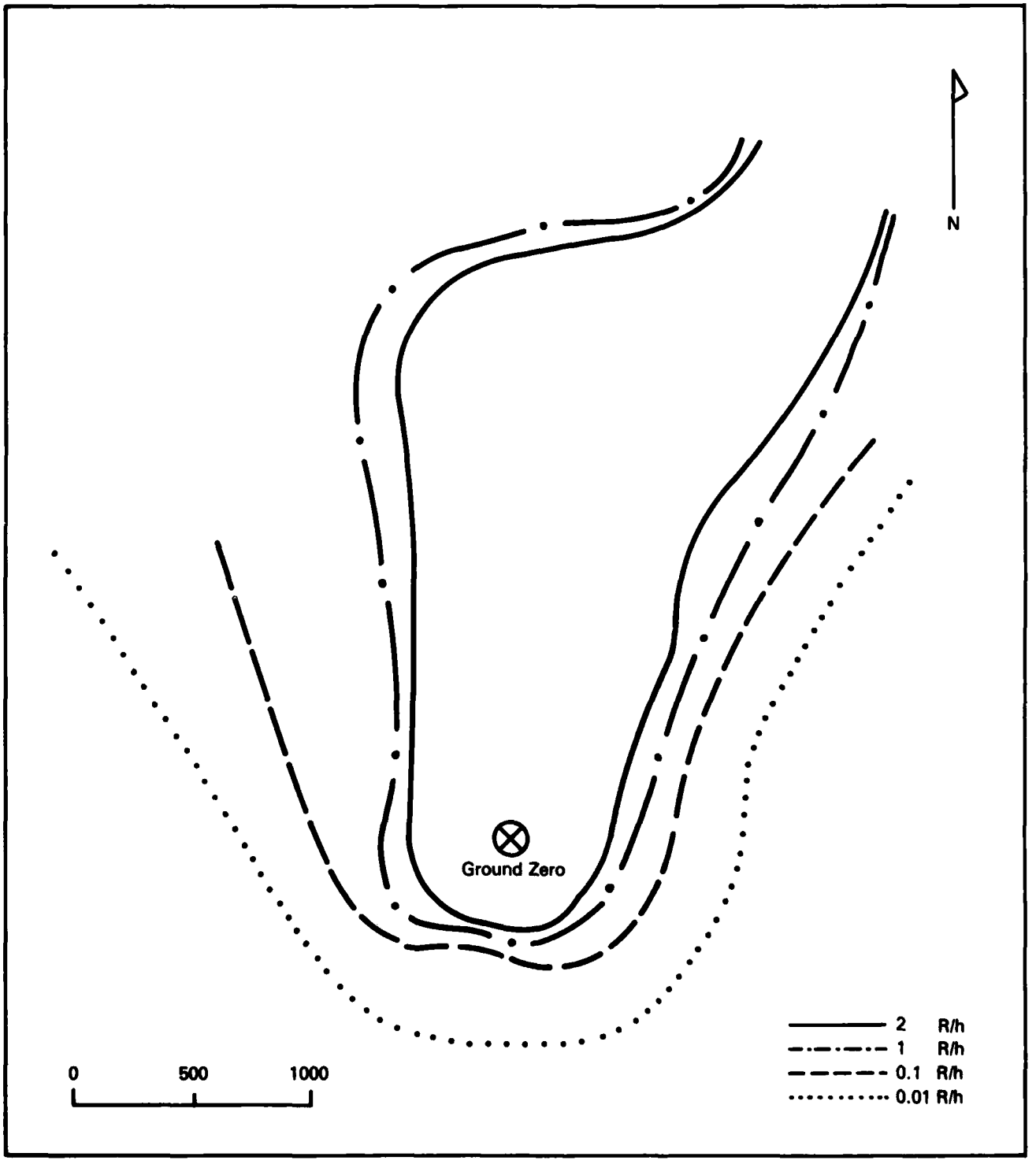


Figure 3-5: RESURVEY FOR SHOT UNCLE, 30 NOVEMBER 1951, 0700 HOURS

REFERENCE LIST

The following list of references represents only those documents consulted in the Shots SUGAR and UNCLE volume. When a DASA-WT or DNA-WT document is followed by an EX, the latest version has been cited. The bibliography of documents consulted during the preparation of all three Operation BUSTER-JANGLE reports is contained in the Operation BUSTER-JANGLE volume.

AVAILABILITY INFORMATION

An availability statement has been included at the end of the reference citation for those readers who wish to read or obtain copies of source documents. Availability statements were correct at the time the bibliography was prepared. It is anticipated that many of the documents marked unavailable may become available during the declassification review process. The Coordination and Information Center (CIC) and the National Technical Information Service (NTIS) will be provided future DNA-WT documents bearing an EX after the report number.

Source documents bearing an availability statement of CIC may be reviewed at the following address:

Department of Energy
Coordination and Information Center
(Operated by Reynolds Electrical & Engineering Co., Inc.)
ATTN: Mr. Richard V. Nutley
2753 S. Highland
P.O. Box 14100 Phone: (702) 734-3194
Las Vegas, Nevada 89114 FTS: 598-3194

Source documents bearing an availability statement of NTIS may be purchased from the National Technical Information Service. When ordering by mail or phone, please include both the price code and the NTIS number. The price code appears in parentheses before the NTIS order number.

National Technical Information Service
5285 Port Royal Road Phone: (703) 487-4650
Springfield, Virginia 22161 (Sales Office)

Additional ordering information or assistance may be obtained by writing to the NTIS, Attention: Customer Service, or by calling (703) 487-4660.

OPERATION BUSTER-JANGLE
SHOTS SUGAR AND UNCLE REFERENCE LIST

1. Alexander, L. T.; et al. "Analysis of Test Site and Fallout Material, JANGLE Project 2.8." (In: Operation JANGLE, Particle Studies, WT-371-EX, 417 pages.) Department of Agriculture. Washington,D. C.: DNA. WT-335. October 1979. 35 Pages. (A15) AD/A995 072.*

2. Allen, P. W.; et al. Transport of Radioactive Debris from Operation BUSTER and JANGLE, Project 7.1. Headquarters, Air Force. Washington, D. C.: DNA. WT-308-EX. October 1979. 187 Pages. (A09) AD/B951 736.*

3. Andrews, T. J.; et al. "Transient Ground Mechanical Effects from HE and Nuclear Explosions, JANGLE Project 1.2a-2." Ballistic Research Laboratories. Washington, D. C.: AFSWP. WT-385. June 1952. 67 Pages.***

4. Armed Forces Special Weapons Project. Summary Report: Weapons Effects Tests, Operation JANGLE. Washington, D. C.: DNA. WT-414-EX. October 1979. 153 Pages. (A08) AD/A995 000.*

5. Armour Research Foundation. Air Force Structures Test, JANGLE Project 3.3. Armour Research Foundation. Washington, D. C.: AFSWP. WT-405. November 1952. 636 Pages.***

6. Ballou, N. E.; Bunney, L. R. "Nature and Distribution of Residual Contamination II, JANGLE Project 2.6c-2." (In: Operation JANGLE, Radiochemical Measurements and Sampling Techniques, WT-373-EX, 263 pages.) Naval Radiological Defense Laboratory. Washington, D. C.: DNA. WT-397. October 1979. 75 Pages. (A12) AD/A995 013.*

7. Barr, H. C. "Ground Technical Photography Material Operations, JANGLE Project 4.1a-1." Sandia Corporation. Washington, D. C.: AFSWP. WT-398. November 1951. 29 Pages.***

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

8. Beach, D. E., Col., USA. "Observer's Report on Operation Desert Rock III," w/o incls. [Carlisle, PA.: Army War College.] December 1951. 5 Pages.**

9. Bishop, J. A.; Lowance, F. E. "Physical Characteristics of Crater and Lip, JANGLE Project 4.2." Naval Civil Engineering Research and Evaluation Laboratory. Washington, D.C.: AFSWP. WT-399. May 1952. 37 Pages.***

10. Bishop, J. A.; et al. "Engineer Soil Mechanics Tests, JANGLE Project 3.29." Naval Civil Engineering Research and Evaluation Laboratory. Washington, D. C.: AFSWP. WT-336. February 1952. 53 Pages. (A04) AD 801 300.*

11. Caris, E. J.; Terry, J. H. "Gamma Radiation as a Function of Time with Droppable Telemeters, JANGLE 2.1b." Naval Air Development Center. Washington, D. C.: AFSWP. WT-392. April 1952. 55 Pages. (A04) AD/A078 575.*

12. Chambers, F. W. "Gamma Depth Dose Measurements in Unit-Density Material, JANGLE Project 2.4b." (In: Operation JANGLE, Biological Hazards, WT-372, 241 pages.) Naval Medical Research Institute. Washington, D. C.: AFSWP. WT-332. May 1952. 36 Pages. (A11) AD 611 250.*

13. Cook, G. W.; Kiley, W. P. "Detection of Time of Arrival First Earth Motion, JANGLE Project 1.5b." David Taylor Model Basin. Washington, D. C.: AFSWP. WT-326. April 1952. 25 Pages.***

14. Costrell, L. "Gamma Radiation as a Function of Time and Distance, JANGLE 2.1a." (In: Operation JANGLE, Gamma Radiation Measurements, WT-370, 339 pages.) National Bureau of Standards. Washington, D. C.: AFSWP. WT-329. April 1952. 107 Pages. (A06) AD/A078 575.*

15. Crawford, F. M. "Aerial Technical Photography, JANGLE Project 4.1." Wright Air Development Center. Washington, D. C.: AFSWP. WT-354. March 1952. 23 Pages.***

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

16. Crocker, J. A. Seismic Waves from A-Bombs Detonated over a Land Mass, BUSTER Project 7.5, JANGLE Project 7.2. Headquarters, Air Force. Washington, D. C.: AFSWP. WT-321. March 1952. 123 Pages. (A06).*

17. Doll, E. B.; Salmon, V. Ground Acceleration, Ground and Air Pressures for Underground Test, JANGLE Project 1(9)a. Stanford Research Institute. Washington, D. C.: AFSWP. WT-380. April 1952. 99 Pages. (A05) AD/A995 076.*

18. Earl, J. R.; et al. Protection and Decontamination of Land Targets and Vehicles, JANGLE Project 6.2. Naval Radiological Defense Laboratory. Washington, D. C.: AFSWP. WT-400. June 1952. 229 Pages.***

19. Eberhard, R. A.; et al. "Peak Air Blast Pressures from Shock Velocity Measurements along the Ground, JANGLE Project 1.2a-1." Ballistic Research Laboratories. Washington, D. C.: AFSWP. WT-323. 1951. 65 Pages.***

20. Emmquist, E. H. "Evaluation of the Potential Respiratory Hazard to Tank Crews Required to Operate in Contaminated Areas, JANGLE Project 6.3-2." Army Chemical Center. Washington, D. C.: AFSWP. WT-402. July 1952. 55 Pages.***

21. Fackler, P. H. Interview with Col. Paul H. Fackler, USAF (Ret.), Subject: CONUS Tests. McLean, VA. April 22, 1981.***

22. Fackler, P. H., Lt. Col., USAF. Technical Air Operations. Air Force Special Weapons Command. Kirtland AFB, NM.: SWC. WT-422. January 1952. 87 Pages.***

23. Forbes, M. B., LTC, USA. "Evaluation of Military Radiac Equipment, JANGLE Project 6.1." Army Electronics Laboratory and Navy, Bureau of Ships. Washington, D. C.: AFSWP. WT-337. May 1952. 61 Pages.***

24. Forbes, M. B., LTC, USA. "Total Dosage, JANGLE Project 2.3-1." (In: Operation JANGLE, Gamma Radiation Measurements, WT-370, 339 pages.) Signal Corps Engineering Laboratories. Washington, D. C.: AFSWP. WT-331. March 1952. 49 Pages. (A15) AD/A078 575.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

25. Forbes, M. B., LTC, USA; et al. "Remotely Controlled Sampling Techniques, JANGLE Project 2.6a." (In: Operation JANGLE, Radiochemical Measurements and Sampling Techniques, WT-373-EX, 263 pages.) Signal Corps Engineering Laboratories. Washington, D. C.: AFSWP. WT-334. January 1979. 49 Pages. (A12) AD/A995 013.*

26. Gannon, W. F. "Close in Ground Measurements, JANGLE Project 1.2b." (In: Operation JANGLE, Blast and Shock Measurements II, WT-367, 231 pages.) Sandia Corporation and AFSWP. Washington, D. C.: AFSWP. WT-364. March 1952. 39 Pages. (A11) AD/A078 577.*

27. General Electric Company--TEMPO. Compilation of Local Fallout Data from Test Detonations 1945-1962. Vol. 1: "Continental US Tests." Washington, D. C.: Defense Nuclear Agency. DNA 1251-1(EX.). 1979. 612 Pages. (A99) AD/A079 309.*

28. Gerster, Max. The Special Weapons Center and Atomic Testing. Air Force Special Weapons Center. Kirtland AFB, NM.: AFSWC. K242.04. January 1957. 305 Pages.***

29. Hansen, R. J.; Archer, J. S. "Army Structures Test, JANGLE Project 3.2." Massachusetts Institute of Technology. Washington, D. C.: AFSWP. WT-387. October 1952. 477 Pages.***

30. Hansen, R. J.; Saxe, H. C. Ground Acceleration (Shock Pins), JANGLE Project 1.7. Massachusetts Institute of Technology. Washington, D. C.: AFSWP. WT-357. June 1952. 79 Pages.***

31. Harlan, W. E. "Aerial Survey of Distant Contaminated Terrain, JANGLE Project 2.1C-1." (In: Operation JANGLE, Gamma Radiation Measurements, WT-370, 339 pages.) Headquarters, Air Force. Washington, D. C.: AFSWP. WT-330. June 1952. 27 Pages. (A15) AD/A078 575.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

32. Haskell, N. A.; Vann, J. D. "The Measurement of Free Air Atomic Blast Pressure, JANGLE Project 1.3c." (In: Operation JANGLE, Blast and Shock Measurements II, WT-367, 231 pages.) Air Force Cambridge Research Center. Washington, D. C.: AFSWP. WT-325. April 1952. 67 Pages. (A11) AD/A078 577.*

33. Hatlem, J. C., Lt. Col., USAF. Special Weapons Command Participation in Operation BUSTER-JANGLE. Air Force, Special Weapons Command. Kirtland AFB, NM.: SWC. 1951. 139 Pages.***

34. Hazzard, L. B.; McEleney, P. J. Navy Underground and Surface Structures, JANGLE Project 3.1. Bureau of Yards and Docks. Washington, D. C.: AFSWP. WT-404. May 1953. 255 Pages.***

35. Headquarters, Camp Desert Rock. Memorandum for Carroll L. Tyler, Test Manager, Subject: Desert Rock III Schedule. Camp Desert Rock, NV. 25 November 1951. 2 Pages.**

36. Headquarters, Camp Desert Rock. [Memorandum, Subject: Selected Officers and Enlisted Men to Participate as Observers in Exercise Desert Rock III.] Camp Desert Rock, NV. 27 November 1951. 3 Pages.**

37. [Headquarters, Camp Desert Rock.] Report of Test Exercises Desert Rock II and III. [Sixth Army.] Camp Desert Rock, NV.: HQS. Camp Desert Rock, 15 December 1951. 274 Pages. (A12) AD/B951 583.*

38. Hendrickson, J. R. Evaluation of Military Individual and Collective Protection Devices and Clothing, JANGLE Project 6.3-1. Army Chemical Center. Washington, D. C.: AFSWP. WT-401. July 1952. 77 Pages.***

39. Howard, W. J.; Jones, R. D. "Free Air Pressure Measurements, JANGLE Project 1.4." (In: Operation JANGLE, Blast and Shock Measurements II, WT-367, 231 pages.) Sandia Corporation. Washington, D. C.: AFSWP. WT-306. February 1952. 39 Pages. (A11) AD/A078 577.*

40. Hughes, D. C.; et al. Clothing Decontamination and Evaluation of Laundry Methods, JANGLE Project 6.7. Office of the Quartermaster General. Washington, D. C.: AFSWP. WT-347. April 1952. 85 Pages.***

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

41. James, F. E. "Operational Tests of Techniques for Accomplishing Indirect Bomb Damage Assessment, BUSTER Project 6.5, JANGLE Project 6.4." Wright Air Development Center. Washington, D. C.: AFSWP. WT-344. March 1952. 56 Pages. (A04) AD/A995 164.*

42. Johnson, G. W. "Monitor Survey of Ground Contamination, JANGLE Project 2.1d." AFSWP. Washington, D. C.: AFSWP. WT-381. May 1952. 33 Pages. (A03) AD 454 866.*

43. Karstens, E. H. Air Weather Service Participation in Operation JANGLE, Project 1(8)b. Air Weather Service. Washington, D. C.: AFSWP. WT-361. December 1951. 120 Pages.***

44. Lenander, H. E. "Structure Instrumentation, JANGLE Project 3.28." Sandia Corporation. Washington, D. C.: AFSWP. WT-406. October 1952. 25 Pages.***

45. Lindsten, D. C.; Lowe, H. N., Jr. "Evaluation of U. S. Army Field Water Supply Equipment and Operations, JANGLE Project 6.8." Engineer Research and Development Laboratories. Washington, D. C.: AFSWP. WT-340. May 1952. 25 Pages. (A02) AD 633 639.*

46. Maxwell, C. R. Nature and Distribution of Residual Contamination I, JANGLE Project 2.6c-1. (In: Operation JANGLE, Radiochemical Measurements and Sampling Techniques, WT-373-EX, 263 pages.) National Institutes of Health. Washington, D. C.: AFSWP. WT-386. October 1979. 97 Pages. (A12) AD/A995 013.*

47. Maxwell, C. R.; et al. "Retrievable Missiles for Remote Ground Sampling, JANGLE Project 2.6c-3." (In: Operation JANGLE, Radiochemical Measurements and Sampling Techniques, WT-373-EX, 263 pages.) National Institutes of Health. Washington, D. C.: AFSWP. WT-363. June 1952. 33 Pages. (A12) AD/A995 013.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

48. Maxwell, R. D. "Radiochemical Studies of Large Particles, JANGLE Project 2.5a-3." (In: Operation JANGLE, Particle Studies, WT-371-EX, 417 pages.) Army Medical Service Graduate School. Washington, D. C.: AFSWP. WT-333. April 1952. 31 Pages. (A18) AD/A995 072.*

49. Miller, J. J. "Photographic Analysis, JANGLE Project 4.1a-2." Sandia Corporation. Washington, D. C.: AFSWP. WT-346. March 1952. 43 Pages. (A03) AD/A995 156.*

50. Morris, W. E. Ground Acceleration Measurements, JANGLE Project 1.1. Naval Ordnance Laboratory. Washington, D. C.: AFSWP. WT-388. June 1952. 289 Pages.***

51. Morris, W. E. "Transient Ground Displacement Measurement, JANGLE Project 1.5a." Naval Ordnance Laboratory. Washington, D. C.: AFSWP. WT-382. 1952. 21 Pages.***

52. Moulton, J. F.; et al. "Peak Pressure vs. Distance in Free Air Using Smoke Rocket Photography, JANGLE Project 1.3b." (In: Operation JANGLE, Blast and Shock Measurements II, WT-367, 231 pages.) Naval Ordnance Laboratory. Washington, D. C.: AFSWP. WT-389. June 1952. 59 Pages. (A11) AD/A078 577.*

53. Nadler, M. R., Capt., USAF. "Report of Radiological Safety, Indian Springs AFB, Nevada, Project BUSTER/JANGLE." Air Force, Special Weapons Command. Kirtland AFB, NM: SWC. 5 December 1951. 52 Pages.***

54. Office, Chief of Army Field Forces. [Ltr., OCAFF, ATTNG-43, 12 May 1953, Subject: Troop Participation, Exercise Desert Rock VI, to: CMDT CTGSC. wo/incl.] U. S. Army, OCAFF. Fort Monroe, VA. ATTNG-43 354(C). 12 May 1953. 5 Pages.**

55. Office of the Test Director, J-Division. Operation Order No. 1-51 (BUSTER-JANGLE). Los Alamos, NM.: LASL. J-8000. August 1951. 223 Pages.**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

56. Ohio River Division Laboratories. "Earth Displacement (Shear Shafts), JANGLE Project 1.6." Ohio River Division Laboratories. Washington, D. C.: AFSWP. WT-353. April 1952. 41 Pages.***

57. Olmsted, G. B. Detection of Airborne Low-Frequency Sound from the Atomic Explosions of Operations BUSTER and JANGLE, BUSTER Project 7.6, JANGLE Project 7.3. Headquarters, Air Force. Washington, D. C.: AFSWP. WT-322. March 1952. 147 Pages. (A07) AD/A995 156.*

58. Popoff, I. G.; et al. "Fallout Particle Studies, JANGLE Project 2.5a-2." (In: Operation JANGLE, Particle Studies, WT-371-EX, 417 pages.) Naval Radiological Defense Laboratory. Washington, D. C.: AFSWP. WT-395. April 1952. 149 Pages. (A18) AD/A995 072.*

59. Rankowitz, S.; et al. "Free Air Shock Arrival Times, JANGLE Project 1.3a." (In: Operation JANGLE, Blast and Shock Measurements II, WT-367, 231 pages.) Brookhaven National Laboratory. Washington, D. C.: AFSWP. WT-324. May 1952. 41 Pages. (A11) AD/A078 577.*

60. Robbins, Charles; et al. "Airborne Particle Studies, JANGLE Project 2.5a-1." (In: Operation JANGLE, Particle Studies, WT-371-EX, 417 pages.) Army Chemical Center. Washington, D. C.: AFSWP. WT-394-EX. October 1979. 198 Pages. (A18) AD/A995 072.*

61. Shipman, Thomas, M.D., Rad Safe and Health Director. Memorandum for J. C. Clark, Subject: Policy and Procedure for Rad Safe Organization in Conjunction with Operation Desert Rock. AEC, Rad Safe and Health Unit. Las Vegas, NV. October 4, 1951. 2 Pages.**

62. Shipman, Thomas, M.D. "Radiological Safety, Operation BUSTER-JANGLE." Los Alamos Scientific Laboratory. Los Alamos, NM.: LASL. WT-425-EX. October 1979. 64 Pages. (A04) AD/B951 743.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

63. Singlevich, W.; Douthett, E. M. "Radiochemical, Chemical and Physical Analysis of Atomic Bomb Debris, BUSTER Project 7.3, JANGLE Project 7.1." Headquarters, Air Force. Washington, D. C.: AFSWP. WT-320-EX. January 1979. 23 Pages. (A02) AD/A995 009.*

64. Smith, Falconer; et al. "Biological Injury from Particle Inhalation, JANGLE Project 2.7." (In: Operation JANGLE, Biological Hazards, WT-372, 241 pages.) National Institutes of Health. Washington, D.C.: AFSWP. WT-396. June 1952. 69 Pages. (A11) AD 611 250.*

65. Spence, R. W.; Knight, J. D. "Radiochemical Results, BUSTER-JANGLE Project 10.4." Los Alamos Scientific Laboratory. Washington, D. C.: AFSWP. WT-413. February 1952. 42 Pages.***

66. Taylor, L. B. History of the Air Force Atomic Cloud Sampling. Vol. 1: "Narrative"; Vol. 2: "Appendix." Air Force Special Weapons Center. Kirtland AFB, NM.: AFSWC. 61-142-1. January 1963. 330 Pages.***

67. Terry, J. H.; Robertson, G. D. "Aerial Survey of Local Contaminated Terrain, JANGLE Project 2.1c-2." (In: Operation JANGLE, Gamma Radiation Measurements, WT-370, 339 pages.) Navy, Bureau of Aeronautics, and Wright Air Development Center. Washington, D. C.: AFSWP. WT-351. 1951. 59 Pages. (A15) AD/A078 575.*

68. Tochilin, E.; et al. "Beta-Ray and Gamma-Ray Energy of Residual Contamination, JANGLE Project 2.4a." (In: Operation JANGLE, Biological Hazards, WT-372, 241 pages.) Naval Radiological Defense Laboratory. Washington, D. C.: AFSWP. WT-345. April 1952. 101 Pages. (A11) AD 611 250.*

69. Vaile, R. B., Jr.; Salmon, V. "Evaluation of Missile Hazard, Underground Shot, JANGLE Project 4.5." Stanford Research Institute. Washington, D. C.: AFSWP. WT-338. May 1952. 53 Pages. (A04) AD 629 883.*

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

70. Walsh, T. G. "Foxhole Shielding of Gamma Radiation, JANGLE Project 2.3-2." Engineer Research and Development Laboratories. Washington, D. C.: AFSWP. WT-393. June 1952. 21 Pages. (AO2) AD 482 985.*

71. Warren, Shields, M. D., Director, Div. of Biology and Medicine. Memorandum for Carroll Tyler, Manager SFOO, Subject: Permissible Levels of Radiation Exposure for Test Personnel. AEC. Washington, D. C. October 11, 1951. 2 Pages.**

72. Young, G. A.; Milligan, M. L. "Base Surge Analysis for Nuclear Tests, JANGLE Project 1(9)b." Naval Ordnance Laboratory. Washington, D. C.: AFSWP. WT-390. June 1952. 35 Pages.***

73. Reynolds Electrical and Engineering Company, Inc. Exposure Data Master File--BUSTER-JANGLE. Mercury, NV. REECo. Report 838-00. February 1981. Computer Printout.****

74. Goodyear, Mark V., 1st LT, USA. Letter to E. Tochilin, Subject: Gamma Dosage Film Readings from Project 2.4a Stations during the JANGLE Tests. Office of Director, Effects Tests. Washington, D. C. 9 January 1952. 2 Pages.**

*Available from NTIS; order number appears before the asterisk.

**Available at CIC.

***Not available, see Availability Information page.

****Requests subject to Privacy Act restrictions.

DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Armed Forces Staff College
ATTN: Library

Assistant Secretary of Defense, Public Affairs
ATTN: PAO

Defense Nuclear Agency
ATTN: PAO
ATTN: GC
ATTN: BA
5 cy ATTN: NTPR
25 cy ATTN: TITL

Defense Technical Information Center
12 cy ATTN: DD

Field Command
Defense Nuclear Agency
ATTN: FCLS
ATTN: FCTT, W. Summa
ATTN: FCLS, Maj D. Norton
ATTN: FCTT, G. Ganong

Interservice Nuclear Weapons School
ATTN: TTV

National Defense University
ATTN: ICAF Tech Library

Assistant to the Secretary of Defense
Atomic Energy
ATTN: Military Applications
ATTN: Executive Assistant

DEPARTMENT OF THE ARMY

Army Library
ATTN: Military Doc Sec

Army Nuclear Test Personnel Review
2 cy ATTN: DAAG-AMR-R TAGO

U.S. Army Center of Military History
ATTN: DAMH-HSO

U.S. Army Chemical School
ATTN: ATZN-CM-CS
ATTN: ATZN-CM-AL

U.S. Army Comd & General Staff College
ATTN: Library

U.S. Army War College
ATTN: Library

U.S. Army Nuclear & Chemical Agency
ATTN: Library

DEPARTMENT OF THE NAVY

Aviation History Unit
Department of the Navy
ATTN: Library

Bureau of Medicine and Surgery
Department of the Navy
ATTN: Asst for Med Surgery

DEPARTMENT OF THE NAVY (Continued)

James Carson Breckinridge Library
Department of the Navy
ATTN: Library Div

Marine Corps Nuclear Test Personnel Review
ATTN: Code MSRB-60

Merchant Marine Academy
ATTN: Director of Libraries

Naval Aviation School Command
ATTN: Library

Naval Hospital Corps School
ATTN: Library

Naval Ocean Systems Center
ATTN: Library

Naval Oceanographic Office
ATTN: Code 025, Historian

Naval Postgraduate School
ATTN: Code 1424, Library

Naval Research Laboratory
ATTN: Library

Naval School
Naval Construction Battalion Center
ATTN: Commanding Officer

Marine Corps Dev & Education Command
ATTN: J. Breckinridge Lib

Naval Sea Systems Command
ATTN: Nuclear Technology Div

Naval Surface Weapons Center
ATTN: Library

Naval War College
ATTN: Professor & Libraries

Naval Weapons Center
ATTN: Code 233

Naval Weapons Evaluation Facility
ATTN: Library

Navy Dept Library
ATTN: Libm

Navy Nuclear Power School
ATTN: Library

Navy Nuclear Test Personnel Review
2 cy ATTN: W. Loeffler

U.S. Naval Academy
Nimitz Library
ATTN: Documents & Reports Dept

Marine Corps Base
ATTN: Document Custodian

DEPARTMENT OF THE NAVY (Continued)

Office of the Judge Adv Gen
Department of the Navy
ATTN: Code 73

Marine Corps Historical Center
2 cy ATTN: Code HDH-2

U.S. Merchant Marine Academy
ATTN: Librn

U.S. Naval Air Station Library
Department of the Navy
ATTN: Library

DEPARTMENT OF THE AIR FORCE

Academy Library DFSELD
U.S. Air Force Academy
ATTN: Library

Aerospace Defense Command
ATTN: Historian

Air Force Communications Command
ATTN: Historian

Air Force Institute of Technology
ATTN: Library

Air Force Logistics Command
ATTN: Historian

Air Force Nuclear Test Personnel Review
ATTN: HQ USAF/SGES

Air Force School of Aerospace Medicine
ATTN: Strughold Library

Air Force Systems Command
ATTN: Historian

Air Force Technical Applications Center
ATTN: Historian

Air Force Weapons Laboratory
Air Force Systems Command
ATTN: Tech Library

Air National Guard
ATTN: Historian

Air Training Command
ATTN: Historian

Air University Library
Department of the Air Force
ATTN: AUL-LSE

Military Air Lift Command
ATTN: Historian

Commander-in-Chief
Pacific Air Forces
ATTN: Historian

Tactical Air Command
Department of the Air Force
ATTN: Historian

DEPARTMENT OF THE AIR FORCE (Continued)

Strategic Air Command
Department of the Air Force
ATTN: NRI-STINFO Library
ATTN: Historian

U.S. Air Force Occupational & Env Health Lab
ATTN: NTPR

DEPARTMENT OF ENERGY

Department of Energy
ATTN: OMA

Department of Energy
Nevada Operations Office
ATTN: Health Physics Div
2 cy ATTN: R. Nutley

Department of Energy
Human Health & Assessments Division
ATTN: EV-31

OTHER GOVERNMENT AGENCIES

Centers for Disease Control
U.S. Public Health Service
ATTN: G. Caldwell

Central Intelligence Agency
ATTN: Office of Medical Services

Department of Health & Human Svcs
ATTN: Office of General Counsel

Exec Ofc of The President
Management & Budget Off Lib
ATTN: Librn

Library of Congress
ATTN: Library Service Division
ATTN: Science & Technology Div
ATTN: Serial & Govt Publication

National Atomic Museum
ATTN: Historian

Department of Commerce
National Bureau of Standards
ATTN: Librn

Occupational Safety & Health Admin
ATTN: Library

Office of Health & Disability (ASPER)
ATTN: R. Copeland

Ofc of Workers Compensation Program
Department of Labor
ATTN: R. Larson

U.S. Coast Guard Academy Library
ATTN: Librn

U.S. House of Representatives
ATTN: Committee on Armed Svcs

OTHER GOVERNMENT AGENCIES (Continued)

U.S. House of Representatives
Committee on Interstate & Foreign Commerce
ATTN: Subcommittee on Health & Envir

U.S. Military Academy
ATTN: Director of Libraries

U.S. Senate
Committee on Armed Services
ATTN: Committee on Veterans Affairs

U.S. Senate
ATTN: Committee on Veterans Affairs

Veterans Administration-RO
Providence, RI
ATTN: Director

Veterans Administration-RO
Montgomery, AL
ATTN: Director

Veterans Administration-RO
Anchorage, AK
ATTN: Director

Veterans Administration-RO
Phoenix, AZ
ATTN: Director

Veterans Administration-RO
Little Rock, AR
ATTN: Director

Veterans Administration-RO
Los Angeles, CA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

Veterans Administration-RO
Denver, CO
ATTN: Director

Veterans Administration-RO
Hartford, CT
ATTN: Director

Veterans Administration-RO
Wilmington, DE
ATTN: Director

Veterans Administration-OFC Central
Washington, D. C.
ATTN: Dept Veterans Benefit, Central Ofc
ATTN: Director
ATTN: Board of Veteran Appeal

Veterans Administration-RO
St. Petersburg, FL
ATTN: Director

Veterans Administration-RO
Atlanta, GA
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Honolulu, HI
ATTN: Director

Veterans Administration-RO
Chicago, IL
ATTN: Director

Veterans Administration-RO
Seattle, WA
ATTN: Director

Veterans Administration-RO
Indianapolis, IN
ATTN: Director

Veterans Administration-RO
Des Moines, IA
ATTN: Director

Veterans Administration-RO
Wichita, KS
ATTN: Director

Veterans Administration-RO
Louisville, KY
ATTN: Director

Veterans Administration-RO
New Orleans, LA
ATTN: Director

Veterans Administration-RO
Togus, ME
ATTN: Director

Veterans Administration-RO
Baltimore, MD
ATTN: Director

Veterans Administration-RO
Boston, MA
ATTN: Director

Veterans Administration-RO
St. Paul, MN
ATTN: Director

Veterans Administration-RO
Jackson, MS
ATTN: Director

Veterans Administration-RO
Huntington, WV
ATTN: Director

Veterans Administration-RO
St. Louis, MO
ATTN: Director

Veterans Administration-RO
Ft. Harrison, MT
ATTN: Director

National Archives
ATTN: Librn

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Lincoln, NE
ATTN: Director

Veterans Administration-RO
Reno, NV
ATTN: Director

Veterans Administration-RO
Manchester, NH
ATTN: Director

Veterans Administration-RO
Newark, NJ
ATTN: Director

Veterans Administration-RO
Milwaukee, WI
ATTN: Director

Veterans Administration-RO
Albuquerque, NM
ATTN: Director

Veterans Administration-RO
Buffalo, NY
ATTN: Director

Veterans Administration-RO
New York, NY
ATTN: Director

Veterans Administration-RO
Winston-Salem, NC
ATTN: Director

Veterans Administration-RO
Fargo, ND
ATTN: Director

Veterans Administration-RO
Cleveland, OH
ATTN: Director

Veterans Administration-RO
Muskogee, OK
ATTN: Director

Veterans Administration-RO
Portland, OR
ATTN: Director

Veterans Administration-RO
Pittsburgh, PA
ATTN: Director

Veterans Administration-RO
Philadelphia, PA
ATTN: Director

Veterans Administration-RO
San Francisco, CA
ATTN: Director

Veterans Administration-RO
San Juan, Puerto Rico
ATTN: Director

OTHER GOVERNMENT AGENCIES (Continued)

Veterans Administration-RO
Columbia, SC
ATTN: Director

Veterans Administration-RO
Sioux Falls, SD
ATTN: Director

Veterans Administration-RO
Houston, TX
ATTN: Director

Veterans Administration-RO
Waco, TX
ATTN: Director

Veterans Administration-RO
Salt Lake City, UT
ATTN: Director

Veterans Administraiton-RO
White River Junction VT
ATTN: Director

Veterans Administration-RO
Roanoke, VA
ATTN: Director

Veterans Administration-RO
Cheyenne, WY
ATTN: Director

Veterans Administration-RO
San Diego, CA
ATTN: Director

Veterans Administration-RO
Boise, ID
ATTN: Director

Veterans Administration-RO
Detroit, MI
ATTN: Director

Veterans Administration-RO
Nashville, TN
ATTN: Director

The White House
ATTN: Domestic Policy Staff

DEPARTMENT OF ENERGY CONTRACTORS

Lawrence Livermore National Lab
ATTN: Tech Info Dept Library

Los Alamos National Lab
ATTN: Library
2 cy ATTN: ADPA MMS 195

Sandia National Lab
ATTN: W. Hereford
ATTN: Central Library

Reynolds Electrical & Engr Co., Inc
ATTN: CIC
ATTN: W. Brady

OTHER

Adams State College
ATTN: Librn

Akron Public Library
ATTN: Librn

Alabama State Dept of Archives & History
ATTN: Military Records Div

University of Alabama
ATTN: Reference Dept/Docs

University of Alaska Library at Anchorage
ATTN: Librn

University of Alaska
ATTN: Dir of Libraries

Albany Public Library
ATTN: Librn

Alexander City State Jr College
ATTN: Librn

Allegheny College
ATTN: Librn

Allen County Public Library
ATTN: Librn

Altoona Area Public Library
ATTN: Librn

American Statistics Index
Congressional Info Service, Inc
ATTN: Cathy Jarvey

Anaheim Public Library
ATTN: Librn

College of Wooster
ATTN: Gov Docs

Angelo State University Library
ATTN: Librn

Angelo Iacoboni Public Library
ATTN: Librn

Anoka County Library
ATTN: Librn

Appalachian State University
ATTN: Library Docs

Arizona State University Library
ATTN: Librn

University of Arizona
ATTN: Gov Doc Dept/C. Bower

Arkansas College Library
ATTN: Library

Brooklyn College
ATTN: Doc Div

OTHER (Continued)

Arkansas Library Comm
ATTN: Library

Arkansas State University
ATTN: Library

University of Arkansas
ATTN: Gov Docs Div

Austin College
ATTN: Librn

Atlanta Public Library
ATTN: Ivan Allen Dept

Atlanta University
ATTN: Librn

Auburn University Library at Mongomery (Reg)
ATTN: Librn

C. W. Post Ctr Long Island University
ATTN: Librn

Bangor Public Library
ATTN: Librn

Bates College Library
ATTN: Librn

Baylor University Library
ATTN: Docs Dept

Beloit College Libraries
ATTN: Serials Docs Dept

Bemidji State College
ATTN: Library

State University College
ATTN: Gov Docs

Akron University
ATTN: Gov Docs

Boston Public Library (Reg)
ATTN: Docs Dept

Bowdoin College
ATTN: Librn

Bowling Green State University
ATTN: Lib Gov Docs Services

Bradley University
ATTN: Librn

Brandeis University Library
ATTN: Docs Section

Brigham Young University
ATTN: Librn

Brigham Young University
ATTN: Docs Collection

Brookhaven National Laboratory
ATTN: Tech Library

OTHER (Continued)

Broward County Library Sys
ATTN: Librn

Brown University
ATTN: Librn

Bucknell University
ATTN: Reference Dept

Buffalo & Erie Co Public Library
ATTN: Librn

State University Library of California at Fresno
ATTN: Library

University Library of California at Los Angeles
ATTN: Pub Affairs Serv U.S. Docs

University of California at San Diego
ATTN: Docs Dept

State College Library of California at Stanislaus
ATTN: Library

California State Polytechnic University Library
ATTN: Librn

California State University at Northridge
ATTN: Gov Doc

California State Library (Reg)
ATTN: Librn

California State University at Long Beach Library
ATTN: Librn

California State University
ATTN: Librn

California State University
ATTN: Librn

California University Library
ATTN: Gov Pub Dept

California University Library
ATTN: Librn

California University Library
ATTN: Gov Docs Dept

California University Library
ATTN: Docs Sec

University of California
ATTN: Gov Docs Dept

Calvin College Library
ATTN: Librn

Kearney State College
ATTN: Gov Docs Dept

Carleton College Library
ATTN: Librn

OTHER (Continued)

Carnegie Library of Pittsburgh
ATTN: Librn

Carnegie Mellon University
ATTN: Dir of Libraries

Carson Regional Library
ATTN: Gov Pubs Unit

Case Western Reserve University
ATTN: Librn

Casper College
ATTN: Librn

University of Central Florida
ATTN: Library Docs Dept

Central Michigan University
ATTN: Library Docs Sec

Central Missouri State Univ
ATTN: Gov Docs

Central State University
ATTN: Lib Docs Dept

Central Washington University
ATTN: Lib Docs Sec

Central Wyoming College Library
ATTN: Librn

Charleston County Library
ATTN: Librn

Charlotte & Mechlenburg County Public Library
ATTN: E. Correll

Chattanooga Hamilton County, Bicentennial Library
ATTN: Librn

Chesapeake Public Library System
ATTN: Librn

Chicago Public Library
ATTN: Gov Pubs Dept

State University of Chicago
ATTN: Librn

Chicago University Library
ATTN: Dir of Libraries
ATTN: Docs Processing

Cincinnati University Library
ATTN: Librn

Claremont Colleges Libraries
ATTN: Doc Collection

Clemson University
ATTN: Dir of Libraries

OTHER (Continued)

Cleveland Public Library
ATTN: Docs Collection

Cleveland State University Library
ATTN: Librn

Coe Library
ATTN: Docs Div

Colgate University Library
ATTN: Ref Lib

Colorado State University Libraries
ATTN: Librn

University of Colorado Libraries
ATTN: Dir of Libraries

Columbia University Library
ATTN: Docs Svc Ctr

Columbus & Franklin Cty Public Library
ATTN: Gen Rec Div

Compton Library
ATTN: Librn

Connecticut State Library (Reg)
ATTN: Librn

University of Connecticut
ATTN: Gov't of Connecticut

University of Connecticut
ATTN: Dir of Libraries

Cornell University Library
ATTN: Librn

Corpus Christi State University Library
ATTN: Librn

Culver City Library
ATTN: Librn

Curry College Library
ATTN: Librn

Dallas County Public Library
ATTN: Librn

Dallas Public Library
ATTN: Librn

Dalton Junior College Library
ATTN: Librn

Dartmouth College
ATTN: Librn

Davenport Public Library
ATTN: Librn

Davidson College
ATTN: Librn

OTHER (Continued)

Dayton & Montgomery City Public Library
ATTN: Librn

University of Dayton
ATTN: Librn

Decatur Public Library
ATTN: Librn

Dekalb Community College So Cpus
ATTN: Librn

Delaware Pauw University
ATTN: Librn

University of Delaware
ATTN: Librn

Delta College Library
ATTN: Librn

Delta State University
ATTN: Librn

Denison University Library
ATTN: Librn

Denver Public Library (Reg)
ATTN: Docs Div

Dept of Library & Archives (Reg)
ATTN: Librn

Detroit Public Library
ATTN: Librn

Burlington Library
ATTN: Librn

Dickinson State College
ATTN: Librn

Alabama Agricultural Mechanical University & Coll
ATTN: Librn

Drake University
ATTN: Cowles Library

Drew University
ATTN: Librn

Duke University
ATTN: Pub Docs Dept

Duluth Public Library
ATTN: Docs Sec

East Carolina University
ATTN: Lib Docs Dept

East Central University
ATTN: Librn

East Islip Public Library
ATTN: Librn

OTHER (Continued)

East Orange Public Library
ATTN: U.S. Gov't Depository

East Tennessee State University Sherrod Library
ATTN: Docs Dept

East Texas State University
ATTN: Library

Monmouth County Library Eastern Branch
ATTN: Librn

Eastern Illinois University
ATTN: Librn

Eastern Kentucky University
ATTN: Librn

Eastern Michigan University Library
ATTN: Library

Eastern Montana College Library
ATTN: Docs Dept

Eastern New Mexico University
ATTN: Librn

Eastern Oregon College Library
ATTN: Librn

Eastern Washington University
ATTN: Librn

El Paso Public Library
ATTN: Docs & Geneology Dept

Elko County Library
ATTN: Librn

Elmira College
ATTN: Librn

Elon College Library
ATTN: Librn

Enoch Pratt Free Library
ATTN: Docs Ofc

Emory University
ATTN: Librn

Evansville & Vanderburgh Cty Public Library
ATTN: Librn

Everett Public Library
ATTN: Librn

Fairleigh Dickinson University
ATTN: Depository Dept

Florida A & M University
ATTN: Librn

Florida Atlantic University Library
ATTN: Div of Pub Docs

OTHER (Continued)

Florida Institute of Technology
ATTN: Library

Florida International University Library
ATTN: DLCS Sec

Florida State Library
ATTN: Docs Sec

Florida State University
ATTN: Librn

University of Florida
ATTN: Docs Dept

Fond Du Lac Public Library
ATTN: Librn

Ft Hays State University
Ft Hays Kansas State College
ATTN: Librn

Ft Worth Public Library
ATTN: Librn

Free Public Library of Elizabeth
ATTN: Librn

Free Public Library
ATTN: Librn

Freeport Public Library
ATTN: Librn

Fresno Cty Free Library
ATTN: Librn

Gadsden Public Library
ATTN: Librn

Garden Public Library
ATTN: Librn

Gardner Webb College
ATTN: Docs Library

Gary Public Library
ATTN: Librn

Georgetown University Library
ATTN: Gov Docs Room

Georgia Institute of Technology
ATTN: Librn

Georgia Southern College
ATTN: Librn

Georgia Southwestern College
ATTN: Dir of Libraries

Georgia State University Library
ATTN: Librn

OTHER (Continued)

University of Georgia
ATTN: Dir of Libraries (Reg)

Glassboro State College
ATTN: Librn

Gleeson Library
ATTN: Librn

Graceland College
ATTN: Librn

Grand Forks Public City-County Library
ATTN: Librn

Grand Rapids Public Library
ATTN: Dir of Lib

Greenville County Library
ATTN: Librn

Guam RFK Memorial University Library
ATTN: Fed Depository Coll

University of Guam
ATTN: Librn

Gustavus Adolphus College
ATTN: Librn

South Dakota University
ATTN: Librn

Hardin-Simmons University Library
ATTN: Librn

Hartford Public Library
ATTN: Librn

Harvard College Library
ATTN: Dir of Lib

Harvard College Library
ATTN: Serials Rec Div

University of Hawaii Library
ATTN: Gov Docs Coll

Hawaii State Library
ATTN: Fed Docs Unit

University of Hawaii at Monoa
ATTN: Dir of Libraries (Reg)

University of Hawaii
Hilo Campus Library
ATTN: Librn

Haydon Burns Library
ATTN: Librn

Hennepin County Library
ATTN: Gov Docs

Henry Ford Community College Library
ATTN: Librn

OTHER (Continued)

Herbert H. Lehman College
ATTN: Lib Docs Div

Hofstra University Library
ATTN: Docs Dept

Hollins College
ATTN: Librn

Hopkinsville Community College
ATTN: Librn

Wagner College
ATTN: Librn

University of Houston Library
ATTN: Docs Div

Houston Public Library
ATTN: Librn

Tulane University
ATTN: Docs Dept

Hoyt Public Library
ATTN: Librn

Humboldt State College Library
ATTN: Docs Dept

Huntington Park Library
ATTN: Librn

Hutchinson Public Library
ATTN: Librn

Idaho Public Library & Information Center
ATTN: Librn

Idaho State Library
ATTN: Librn

Idaho State University Library
ATTN: Docs Dept

University of Idaho
ATTN: Dir of Libraries (Reg)
ATTN: Docs Sec

University of Illinois Library
ATTN: Docs Sec

Illinois State Library (Reg)
ATTN: Gov Docs Br

Illinois University at Urbana-Champaign
ATTN: P. Watson Docs Lib

Illinois Valley Community College
ATTN: Library

Illinois State University
ATTN: Librn

Indiana State Library (Reg)
ATTN: Serial Sec

Indiana State University
ATTN: Docs Library

OTHER (Continued)

Indiana University Library
ATTN: Docs Dept

Indianapolis Marion County Public Library
ATTN: Social Science Div

Iowa State University Library
ATTN: Gov Docs Dept

Iowa University Library
ATTN: Gov Docs Dept

Butler University
ATTN: Librn

Isaac Delchdo College
ATTN: Librn

James Madison University
ATTN: Librn

Jefferson County Public Library
Lakewood Regional Library
ATTN: Librn

Jersey City State College
ATTN: F. A. Irwin Library Periodicals
Doc Sec

Johns Hopkins University
ATTN: Docs Library

La Roche College
ATTN: Librn

Johnson Free Public Library
ATTN: Librn

Kalamazoo Public Library
ATTN: Librn

Kansas City Public Library
ATTN: Docs Div

Kansas State Library
ATTN: Librn

Kansas State University Library
ATTN: Docs Dept

University of Kansas
ATTN: Dir of Library (Reg)

University of Texas
ATTN: Lyndon B. Johnson School of Public
Affairs Library

Maine Maritime Academy
ATTN: Librn

University of Maine
ATTN: Librn

OTHER (Continued)

Kent State University Library
ATTN: Docs Div

Kentucky Dept of Library & Archives
ATTN: Docs Sec

University of Kentucky
ATTN: Gov Pub Dept
ATTN: Dir of Lib (Reg)

Kenyon College Library
ATTN: Librn

Lake Forest College
ATTN: Librn

Lake Sumter Community College Library
ATTN: Librn

Lakeland Public Library
ATTN: Librn

Lancaster Regional Library
ATTN: Librn

Lawrence University
ATTN: Docs Dept

Brigham Young University
ATTN: Docs & Map Sec

Library and Statutory Dist & Svc
2 cy ATTN: Librn

Earlham College
ATTN: Librn

Little Rock Public Library
ATTN: Librn

Long Beach Public Library
ATTN: Librn

Los Angeles Public Library
ATTN: Serials Div U.S. Docs

Louisiana State University
ATTN: Gov Doc Dept
ATTN: Dir of Libraries (Reg)

Louisville Free Public Library
ATTN: Librn

Louisville University Library
ATTN: Librn

Hoover Institution
ATTN: J. Bingham

OTHER (Continued)

Manchester City Library
ATTN: Librn

Mankato State College
ATTN: Gov Pubs

University of Maine at Farmington
ATTN: Dir of Libraries

Marathon County Public Library
ATTN: Librn

Principia College
ATTN: Librn

University of Maryland
ATTN: McKeldin Library Docs Div

University of Maryland
ATTN: Librn

University of Massachusetts
ATTN: Gov Docs Coll

Maui Public Library
Kahului Branch
ATTN: Librn

McNeese State University
ATTN: Librn

Memphis & Shelby County Public Library & Information Center
ATTN: Librn

Memphis State University
ATTN: Librn

Mercer University
ATTN: Librn

Mesa County Public Library
ATTN: Librn

Miami Dade Community College
ATTN: Librn

University of Miami Library
ATTN: Gov Pubs

Miami Public Library
ATTN: Docs Div

Miami University Library
ATTN: Docs Dept

University of Santa Clara
ATTN: Docs Div

Michigan State Library
ATTN: Librn

Michigan State University Library
ATTN: Librn

Murray State University Library
ATTN; Lib

OTHER (Continued)

Michigan Tech University
ATTN: Lib Docs Dept

University of Michigan
ATTN: Acq Sec Docs Unit

Middlebury College Library
ATTN: Librn

Millersville State College
ATTN: Librn

State University of New York
ATTN: Docs Librn

Milwaukee Public Library
ATTN: Librn

Minneapolis Public Library
ATTN: Librn

University of Minnesota
ATTN: Dir of Libraries (Reg)

Minot State College
ATTN: Librn

Mississippi State University
ATTN: Librn

University of Mississippi
ATTN: Dir of Libraries

Missouri University at Kansas City General
ATTN: Librn

University of Missouri Library
ATTN: Gov Docs

M.I.T. Libraries
ATTN: Librn

Mobile Public Library
ATTN: Gov Info Div

Midwestern University
ATTN: Librn

Montana State Library
ATTN: Librn

Montana State University Library
ATTN: Librn

University of Montana
ATTN: Dir of Libraries (Reg)

Montebello Library
ATTN: Librn

Moorhead State College
ATTN: Library

Mt Prospect Public Library
ATTN: Gov't Info Ctr

OTHER (Continued)

Nassau Library System
ATTN: Librn

Natrona County Public Library
ATTN: Librn

Nebraska Library Community
Nebraska Public Clearinghouse
ATTN: Librn

University of Nebraska at Omaha
ATTN: Univ Lib Docs

Nebraska Western College Library
ATTN: Librn

University of Nebraska
ATTN: Dir of Libraries (Reg)

University of Nebraska Library
ATTN: Acquisitions Dept

University of Nevada Library
ATTN: Gov Pubs Dept

University of Nevada at Las Vegas
ATTN: Dir of Libraries

New Hampshire University Library
ATTN: Librn

New Hanover County Public Library
ATTN: Librn

New Mexico State Library
ATTN: Librn

New Mexico State University
ATTN: Lib Docs Div

University of New Mexico
ATTN: Dir of Libraries (Reg)

University of New Orleans Library
ATTN: Gov Docs Div

New Orleans Public Library
ATTN: Librn

New York Public Library
ATTN: Librn

New York State Library
ATTN: Docs Control Cultural Ed Ctr

State University of New York at Stony Brook
ATTN: Main Lib Docs Sec

State University of New York Col Memorial Lib at Cortland
ATTN: Librn

State University of New York
ATTN: Lib Docs Sec

North Texas State University Library
ATTN: Librn

OTHER (Continued)

State University of New York
ATTN: Librn

New York State University
ATTN: Docs Ctr

State University of New York
ATTN: Docs Dept

New York University Library
ATTN: Docs Dept

Newark Free Library
ATTN: Librn

Newark Public Library
ATTN: Librn

Niagara Falls Public Library
ATTN: Librn

Nicholls State University Library
ATTN: Docs Div

Nieves M. Flores Memorial Library
ATTN: Librn

Norfolk Public Library
ATTN: R. Parker

North Carolina Agricultural & Tech State University
ATTN: Librn

University of North Carolina at Charlotte
ATTN: Atkins Lib Doc Dept

University Library of North Carolina at Greensboro
ATTN: Librn

University of North Carolina at Wilmington
ATTN: Librn

North Carolina Central University
ATTN: Librn

North Carolina State University
ATTN: Librn

University of North Carolina
ATTN: BA SS Div Docs

North Dakota State University Library
ATTN: Docs Librn

University of North Dakota
ATTN: Librn

North Georgia College
ATTN: Librn

Minnesota Div of Emergency Svcs
ATTN: Librn

OTHER (Continued)

Northeast Missouri State University
ATTN: Librn

Northeastern Oklahoma State University
ATTN: Librn

Northeastern University
ATTN: Dodge Library

Northern Arizona University Library
ATTN: Gov Docs Dept

Northern Illinois University
ATTN: Librn

Northern Michigan University
ATTN: Docs

Northern Montana College Library
ATTN: Librn

Northwestern Michigan College
ATTN: Librn

Northwestern State University
ATTN: Librn

Northwestern State University Library
ATTN: Librn

Northwestern University Library
ATTN: Gov Pubs Dept

Norwalk Public Library
ATTN: Librn

Northeastern Illinois University
ATTN: Library

University of Notre Dame
ATTN: Doc Ctr

Oakland Community College
ATTN: Librn

Oakland Public Library
ATTN: Librn

Oberlin College Library
ATTN: Librn

Ocean County College
ATTN: Librn

Ohio State Library
ATTN: Librn

Ohio State University
ATTN: Lib Docs Div

Ohio University Library
ATTN: Docs Dept

Oklahoma City University Library
ATTN: Librn

Oklahoma City University Library
ATTN: Librn

OTHER (Continued)

Oklahoma Department of Libraries
ATTN: U.S. Gov Docs

University of Oklahoma
ATTN: Docs Div

Old Dominion University
ATTN: Doc Dept Univ Lib

Olivet College Library
ATTN: Librn

Omaha Public Library Clark Branch
ATTN: Librn

Onondaga County Public Library
ATTN: Gov Docs Sec

Oregon State Library
ATTN: Librn

University of Oregon
ATTN: Docs Sec

Ouachita Baptist University
ATTN: Librn

Pan American University Library
ATTN: Librn

Passaic Public Library
ATTN: Librn

Queens College
ATTN: Docs Dept

Pennsylvania State Library
ATTN: Gov Pubs Sec

Pennsylvania State University
ATTN: Lib Doc Sec

University of Pennsylvania
ATTN: Dir of Libraries

University of Denver
ATTN: Penrose Library

Peoria Public Library
ATTN: Business, Science & Tech Dept

Free Library of Philadelphia
ATTN: Gov Pubs Dept

Philipsburg Free Public Library
ATTN: Library

Phoenix Public Library
ATTN: Librn

University of Pittsburgh
ATTN: Docs Office, G8

Plainfield Public Library
ATTN: Librn

OTHER (Continued)

Popular Creek Public Library District
ATTN: Librn

Association of Portland Library
ATTN: Librn

Portland Public Library
ATTN: Librn

Portland State University Library
ATTN: Librn

Pratt Institute Library
ATTN: Librn

Louisiana Tech University
ATTN: Librn

Princeton University Library
ATTN: Docs Div

Providence College
ATTN: Librn

Providence Public Library
ATTN: Librn

Public Library Cincinnati & Hamilton County
ATTN: Librn

Public Library of Nashville and Davidson County
ATTN: Librn

University of Puerto Rico
ATTN: Doc & Maps Room

Purdue University Library
ATTN: Librn

Quinebaug Valley Community College
ATTN: Librn

Auburn University
ATTN: Microforms & Docs Dept

Rapid City Public Library
ATTN: Librn

Reading Public Library
ATTN: Librn

Reed College Library
ATTN: Librn

Augusta College
ATTN: Librn

University of Rhode Island Library
ATTN: Gov Pubs Ofc

University of Rhode Island
ATTN: Dir of Libraries

Rice University
ATTN: Dir of Libraries

Louisiana College
ATTN: Librn

OTHER (Continued)

Richland County Public Library
ATTN: Librn

Riverside Public Library
ATTN: Librn

University of Rochester Library
ATTN: Docs Sec

University of Rutgers Camden Library
ATTN: Librn

State University of Rutgers
ATTN: Librn

Rutgers University
ATTN: Dir of Libraries (Reg)

Rutgers University Law Library
ATTN: Fed Docs Dept

Salem College Library
ATTN: Librn

Samford University
ATTN: Librn

San Antonio Public Library
ATTN: Bus Science & Tech Dept

San Diego County Library
ATTN: C. Jones, Acquisitions

San Diego Public Library
ATTN: Librn

San Diego State University Library
ATTN: Gov Pubs Dept

San Francisco Public Library
ATTN: Gov Docs Dept

San Francisco State College
ATTN: Gov Pubs Coll

San Jose State College Library
ATTN: Docs Dept

San Luis Obispo City-County Library
ATTN: Librn

Savannah Public & Effingham Liberty Regional Library
ATTN: Librn

Scottsbluff Public Library
ATTN: Librn

Scranton Public Library
ATTN: Librn

Seattle Public Library
ATTN: Ref Docs Asst

University of Richmond
ATTN: Library

OTHER (Continued)

Selby Public Library
ATTN: Librn

Shawnee Library System
ATTN: Librn

Shreve Memorial Library
ATTN: Librn

Silas Bronson Public Library
ATTN: Librn

Sioux City Public Library
ATTN: Librn

Skidmore College
ATTN: Librn

Slippery Rock State College Library
ATTN: Librn

South Carolina State Library
ATTN: Librn

University of South Carolina
ATTN: Librn

University of South Carolina
ATTN: Gov Docs

South Dakota School of Mines & Technical Library
ATTN: Librn

South Dakota State Library
ATTN: Fed Docs Dept

University of South Dakota
ATTN: Docs Librn

South Florida University Library
ATTN: Librn

Southeast Missouri State University
ATTN: Librn

Southeastern Massachusetts University Library
ATTN: Docs Sec

University of Southern Alabama
ATTN: Librn

Southern California University Library
ATTN: Docs Dept

Southern Connecticut State College
ATTN: Library

Southern Illinois University
ATTN: Librn

Southern Illinois University
ATTN: Docs Ctr

Southern Methodist University
ATTN: Librn

University of Southern Mississippi
ATTN: Library

OTHER (Continued)

Southern Oregon College
ATTN: Library

Southern University in New Orleans Library
ATTN: Librn

Southern Utah State College Library
ATTN: Docs Dept

Southwest Missouri State College
ATTN: Library

University of Southwestern Louisiana Libraries
ATTN: Librn

Southwestern University
ATTN: Librn

Spokane Public Library
ATTN: Ref Dept

Springfield City Library
ATTN: Docs Sec

St Bonaventure University
ATTN: Librn

St Joseph Public Library
ATTN: Librn

St Lawrence University
ATTN: Librn

St Louis Public Library
ATTN: Librn

St Paul Public Library
ATTN: Librn

Stanford University Library
ATTN: Gov Docs Dept

State Historical Soc Library
ATTN: Docs Serials Sec

State Library of Massachusetts
ATTN: Librn

State University of New York
ATTN: Librn

Stetson University
ATTN: Librn

University of Steubenville
ATTN: Librn

Stockton & San Joaquin Public Library
ATTN: Librn

Stockton State College Library
ATTN: Librn

OTHER (Continued)

Superior Public Library
ATTN: Librn

Swarthmore College Library
ATTN: Ref Dept

Syracuse University Library
ATTN: Docs Div

Tacoma Public Library
ATTN: Librn

Hillsborough County Public Library at Tampa
ATTN: Librn

Temple University
ATTN: Librn

Tennessee Technological University
ATTN: Librn

University of Tennessee
ATTN: Dir of Libraries

College of Idaho
ATTN: Librn

Texas A & M University Library
ATTN: Librn

University of Texas at Arlington
ATTN: Library Docs

University of Texas at San Antonio
ATTN: Library

Texas Christian University
ATTN: Librn

Texas State Library
ATTN: U.S. Docs Sec

Texas Tech University Library
ATTN: Gov Docs Dept

Texas University at Austin
ATTN: Docs Coll

University of Toledo Library
ATTN: Librn

Toledo Public Library
ATTN: Social Science Dept

Torrance Civic Center Library
ATTN: Librn

Traverse City Public Library
ATTN: Librn

Trenton Free Public Library
ATTN: Librn

Trinity College Library
ATTN: Librn

Trinity University Library
ATTN: Docs Coll

OTHER (Continued)

Tufts University Library
ATTN: Docs Dept

University of Tulsa
ATTN: Librn

UCLA Research Library
ATTN: Pub Affairs Svc/U.S. Docs

Uniformed Services University of the Health Sciences
ATTN: LRC Library

University Libraries
ATTN: Dir of Lib

University of Maine at Oreno
ATTN: Librn

University of Northern Iowa
ATTN: Library

Upper Iowa College
ATTN: Docs Coll

Utah State University
ATTN: Librn

University of Utah
ATTN: Special Collections

University of Utah
ATTN: Dir of Libraries
ATTN: Dept of Pharmacology

Valencia Library
ATTN: Librn

Vanderbilt University Library
ATTN: Gov Docs Sec

University of Vermont
ATTN: Dir of Libraries

Virginia Commonwealth University
ATTN: Librn

Virginia Military Institute
ATTN: Librn

Virginia Polytechnic Institute Library
ATTN: Docs Dept

Virginia State Library
ATTN: Serials Sec

University of Virginia
ATTN: Pub Docs

Volusia County Public Library
ATTN: Librn

OTHER (Continued)

Washington State Library
ATTN: Docs Sec

Washington State University
ATTN: Lib Docs Sec

Washington University Libraries
ATTN: Dir of Lib

University of Washington
ATTN: Docs Div

Wayne State University Library
ATTN: Librn

Wayne State University Law Library
ATTN: Docs Dept

Weber State College Library
ATTN: Librn

Wesleyan University
ATTN: Docs Librn

West Chester State College
ATTN: Docs Dept

West Covina Library
ATTN: Librn

University of West Florida
ATTN: Librn

West Hills Community College
ATTN: Library

West Texas State University
ATTN: Library

West Virginia College of Grad Studies Library
ATTN: Librn

University of West Virginia
ATTN: Dir of Libraries (Reg)

Westerly Public Library
ATTN: Librn

Western Carolina University
ATTN: Librn

Western Illinois University Library
ATTN: Librn

Western Washington University
ATTN: Librn

Western Wyoming Community College Library
ATTN: Librn

Westmoreland City Community College
ATTN: Learning Resource Ctr

OTHER (Continued)

Whitman College
ATTN: Librn

Wichita State University Library
ATTN: Librn

Williams & Mary College
ATTN: Docs Dept

Emporia Kansas State College
ATTN: Gov Docs Div

William College Library
ATTN: Librn

Willimantic Public Library
ATTN: Librn

Winthrop College
ATTN: Docs Dept

University of Wisconsin at Whitewater
ATTN: Gov Docs Lib

University of Wisconsin at Milwaukee
ATTN: Lib Docs

University of Wisconsin at Oshkosh
ATTN: Librn

University of Wisconsin at Platteville
ATTN: Doc Unit Lib

University of Wisconsin at Stevens Point
ATTN: Docs Sec

University of Wisconsin
ATTN: Gov Pubs Dept

University of Wisconsin
ATTN: Acquisitions Dept

Worcester Public Library
ATTN: Librn

Wright State University Library
ATTN: Gov Docs Librn

Wyoming State Library
ATTN: Librn

University of Wyoming
ATTN: Docs Div

Yale University
ATTN: Dir of Libraries

Yeshiva University
ATTN: Librn

Yuma City County Library
ATTN: Librn

Simon Schwob Mem Lib, Columbus Col
ATTN: Librn

DEPARTMENT OF DEFENSE CONTRACTORS

Advanced Research & Applications Corp
ATTN: H. Lee

JAYCOR
ATTN: A. Nelson
10 cy ATTN: Health & Environment Div

Kaman Tempo
ATTN: DASIAC
ATTN: E. Martin

Kaman Tempo
ATTN: R. Miller

Science Applications, Inc
JRB Associates Div
10 cy ATTN: L. Novotney

DEPARTMENT OF DEFENSE CONTRACTORS (Continued)

Kaman Tempo
ATTN: C. Jones

National Academy of Sciences
ATTN: C. Robinette
ATTN: Med Follow-up Agency
ATTN: Nat Mat Advisory Bd

Pacific-Sierra Research Corp
ATTN: H. Brode, Chairman SAGE

Science Applications, Inc
ATTN: Tech Lib

R & D Associates
ATTN: P. Haas

END

FILMED

2-83

DTIC